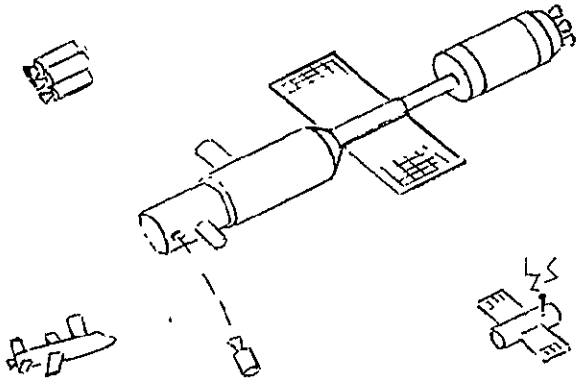
MID-TERM REPORT PRESENTATION -- 26 JUNE 1970



# HOUSEKEEPING CONCEPTS FOR MANNED SPACE SYSTEMS

HABITABILITY
- Architecture
- Environment
- Mobility and Restraint
- Garments and Personal Items
- Food and Water
- Personal Hygiene

HOUSEKEEPING
- Off-Duty Activities



Prepared For

NASA/MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

Contract NAS 9-10662

Doc. No. MS124Y0001
DRL Line Item No. 8



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STUDY TASKS

SURVEYS

WASTE DEFINITION

WASTE UTILIZATION

WASTE DISPOSAL PRETREATMENT

WASTE DISPOSAL

WASTE HANDLING AND HOUSEKEEPING

COMPUTER DATA

USS GATO HABITABILITY

HANDBOOK

RECOMMENDATIONS



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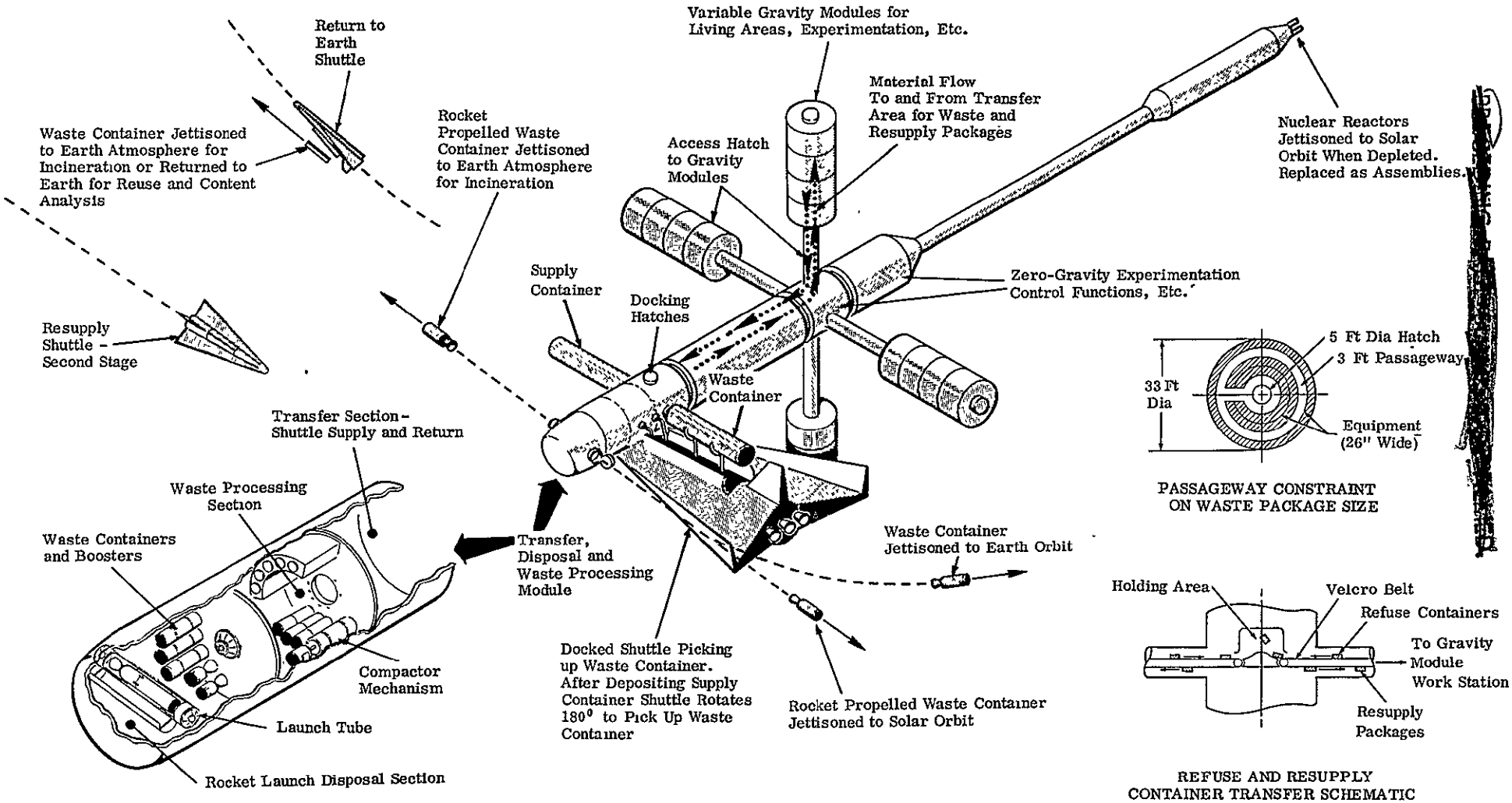
# WASTE DISPOSAL CONCEPTS

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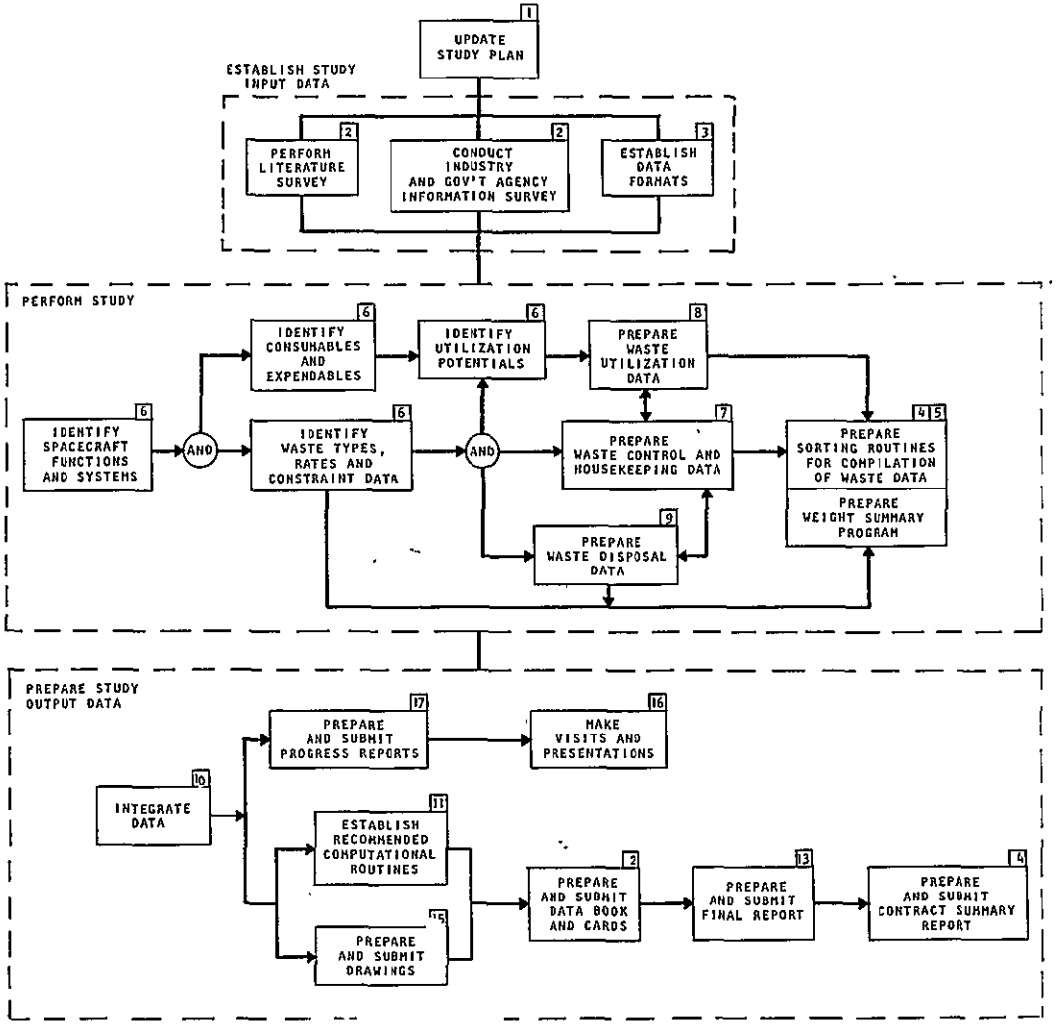
# STUDY TASKS

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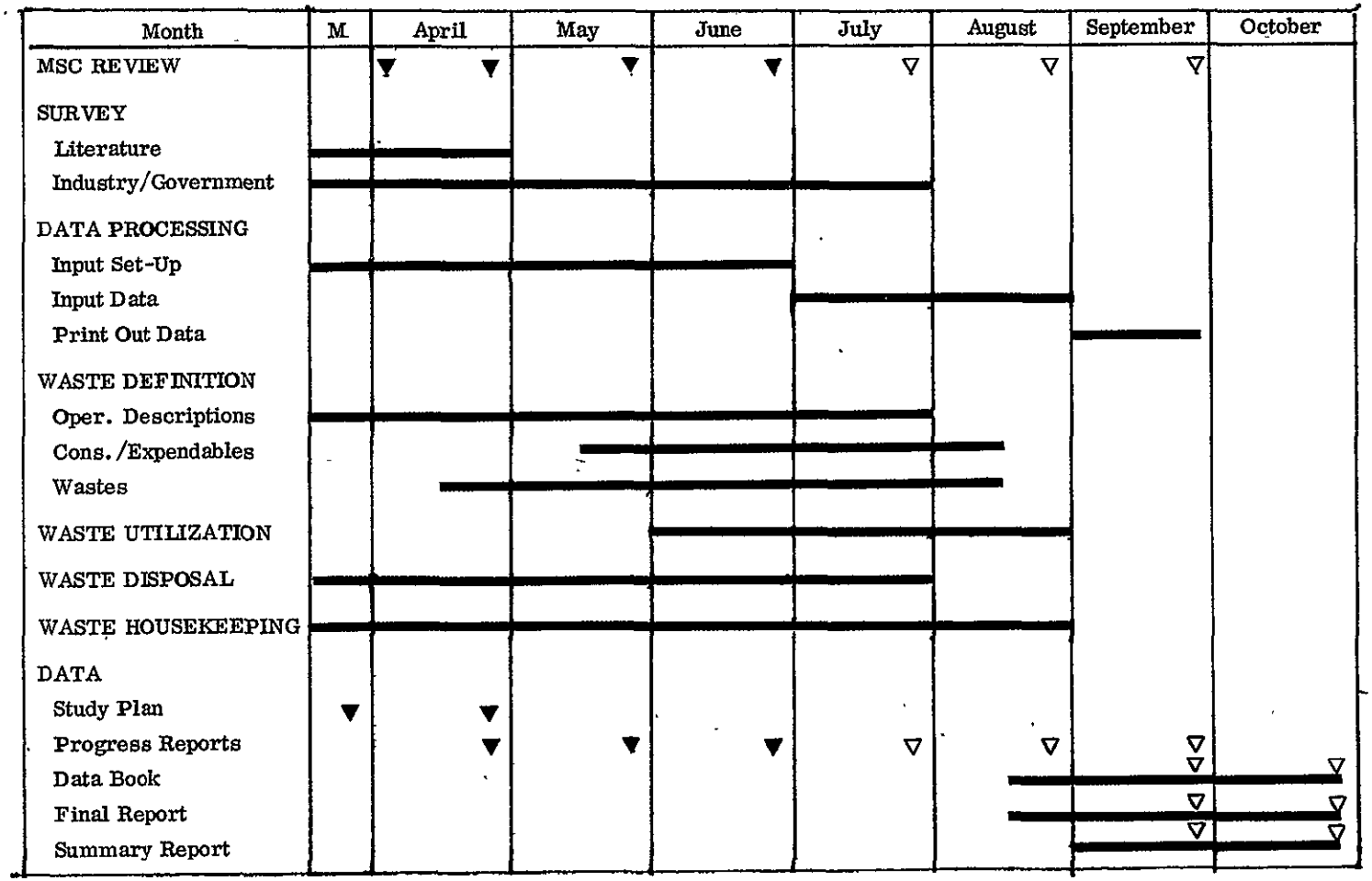
# SCHEDULE

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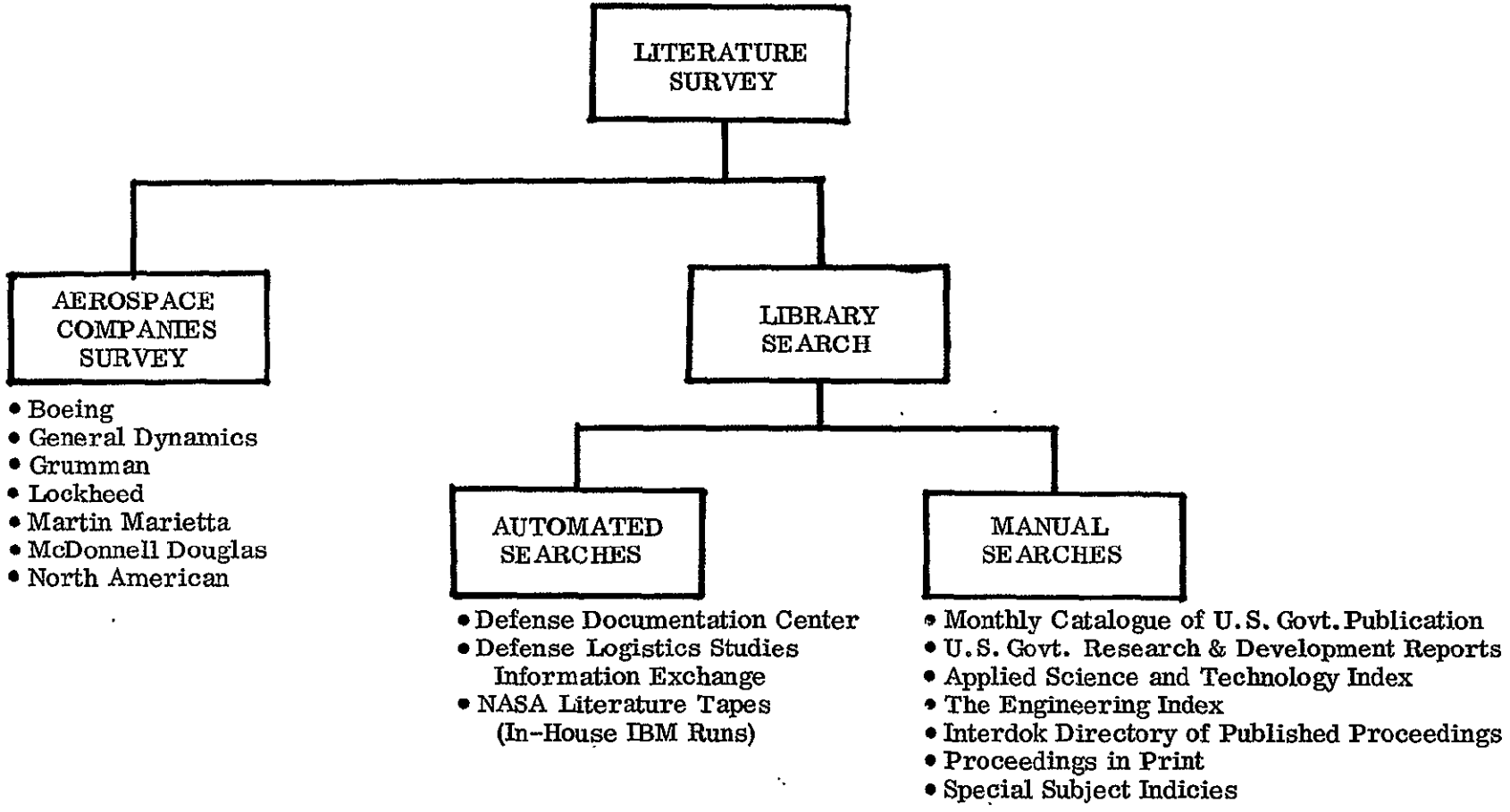
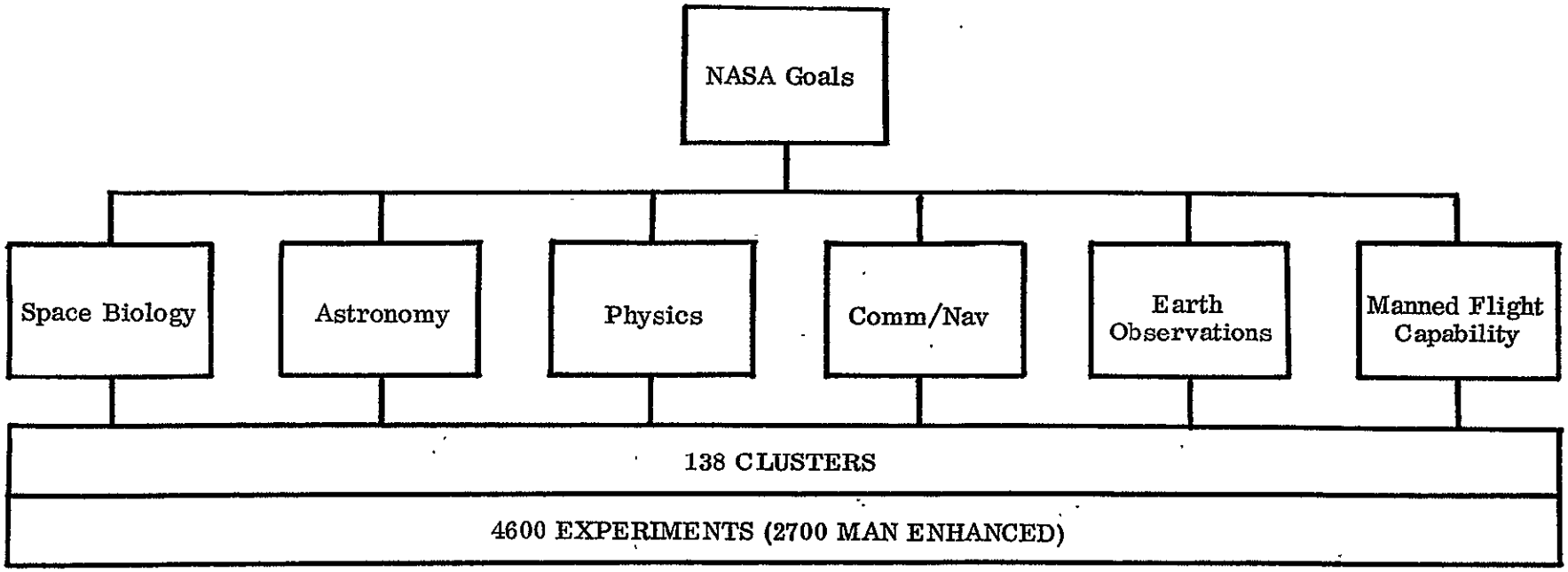
# LITERATURE SURVEY



| | RESPONSE | | |
|---|---|---|---|
| | IN PREPARATION | PARTIAL | COMPLETE |
| BOEING | | | X |
| GENERAL DYNAMICS | | | X |
| GRUMMAN | | | X |
| LOCKHEED | X | | |
| MARTIN | | | |
| McDONNELL DOUGLAS | | X | |
| NORTH AMERICAN ROCKWELL | X | | |
| MSC | | X | |
| MSFC | | | X |
| LaRC | | | X |
| OMSF | | X | |

## WASTE SOURCE FUNCTIONAL AREAS AND WASTE DEFINITION % COMPLETION

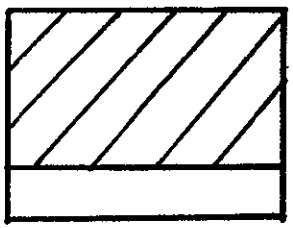
| | | Completion |
|---|---|---|
| 1.0 | SUPPORT LIFE | |
| 1.1 | Monitor and Maintain Crew Health and Safety | 25% |
| 1.2 | Provide Crew Quarters | 25% |
| 1.3 | Provide Crew Food and Drink | 25% |
| 1.4 | Provide for Crew Hygiene | 25% |
| 1.5 | Provide and Control Atmospheric Environment | 0% |
| 2.0 | MAINTAIN SPACECRAFT FUNCTIONS | |
| 2.1 | Control Spacecraft Orbit Position and Attitude | 80% |
| 2.2 | Provide for Electric and Thermal Power | 40% |
| 2.3 | Provide for System Maintenance and Repair | 0% |
| 2.4 | Provide Communication and Navigation | 40% |
| 2.5 | Provide Station Data Collection and Storage | 25% |
| 2.6 | Provide for Spacecraft Logistics | 0% |
| 2.7 | Provide for Experiment Support | 0% |
| 3.0 | PERFORM MISSION TASKS | |
| 3.1 | Astronomy, Astrophysics, and Celestial Mechanics Studies/Tasks | 0% |
| 3.2 | Physics and Chemistry Studies/Tasks | 0% |
| 3.3 | Agriculture and Animal Housing Studies/Tasks | 75% |
| 3.4 | Biology Studies/Tasks | 30% |
| 3.5 | Medical Studies/Tasks | 80% |
| 3.6 | Space Manufacturing Studies/Tasks | 20% |
| 3.7 | Earth Resources and Oceanography Studies/Tasks | 0% |
| 3.8 | Military Sciences Studies/Tasks | 0% |
| 3.9 | Advanced Technology and Engineering | 0% |
| 3.10 | Lunar and Interplanetary Mission Support | 0% |


NASA Goals
Space Biology
Astronomy
Physics
Comm/Nav
Earth Observations
Manned Flight Capability
138 CLUSTERS
4600 EXPERIMENTS (2700 MAN ENHANCED)

EXPERIMENTS

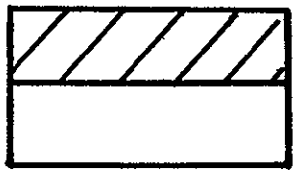
DETAIL PER EXPERIMENT

YELLOW BOOK



PLANNING CATALOG OF ALL PROPOSED SPACE STATION EXPERIMENTS

BLUE BOOK



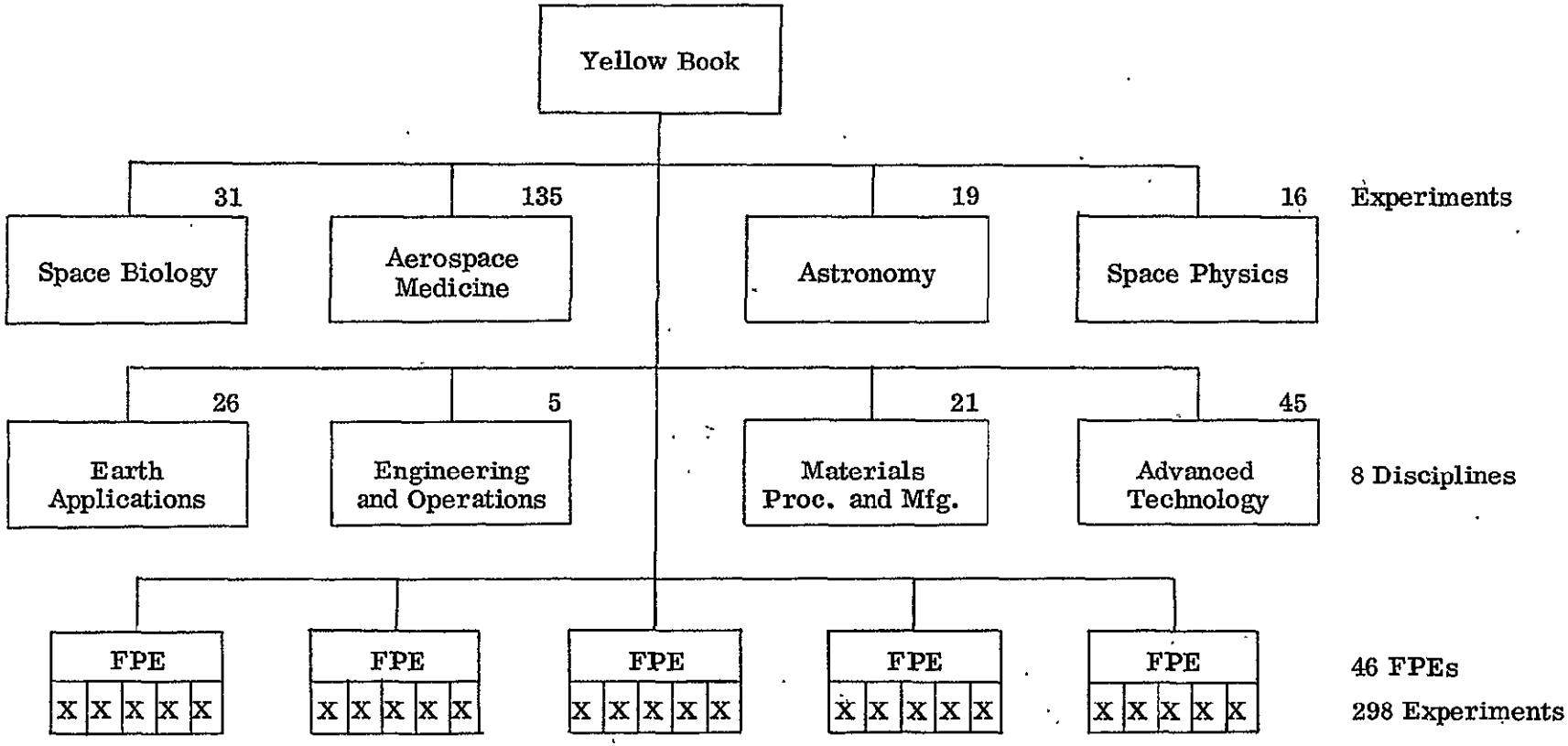
DESIGN REFERENCE DATA FOR SPACE STATION AND SUPPORTING STUDIES

GREEN BOOK

PROPOSED FLIGHT RESEARCH AND EXPERIMENT PLAN

1. GRAZING INCIDENCE X-RAY TELESCOPE
2. ADVANCED STELLAR ASTRONOMY
3. ADVANCED SOLAR ASTRONOMY
4. UV STELLAR SURVEY
5. HIGH ENERGY STELLAR SURVEY
6. SPACE PHYSICS AIRLOCK
7. PLASMA PHYSICS AND ENV. PERTURBATIONS
8. COSMIC RAY PHYSICS LAB
9. SMALL VERTEBRATES (BIO D)
10. PLANT SPECIMENS (BIO E)
11. EARTH SURVEYS
12. REMOTE MANEUVERING SUBSATELLITE
13. BIOMEDICAL AND BEHAVIORAL RESEARCH
14. MAN SYSTEM INTEGRATION
15. LIFE SUPPORT AND PROTECTIVE SYSTEMS
16. MATERIALS SCIENCE AND PROCESSING
17. CONTAMINATION MEASUREMENTS
18. EXPOSURE EXPERIMENTS
19. EXTENDED SPACE STRUCTURE DEVELOPMENT
20. FLUID PHYSICS IN MICROGRAPHY
21. INFRARED STELLAR SURVEY
22. COMPONENT TEST AND SENSOR CALIBRATION
23. ADVANCED SPACECRAFT SYSTEM TESTS
24. MSF ENGINEERING AND OPERATIONS
25. MICROBIOLOGY (BIO C)
26. INVERTEBRATES (BIO F)

# ORGANIZATION OF OMSF YELLOW BOOK (REV. 1, SEPT. 1, 1969) EXPERIMENT PROGRAM




FPE = Functional Program Element

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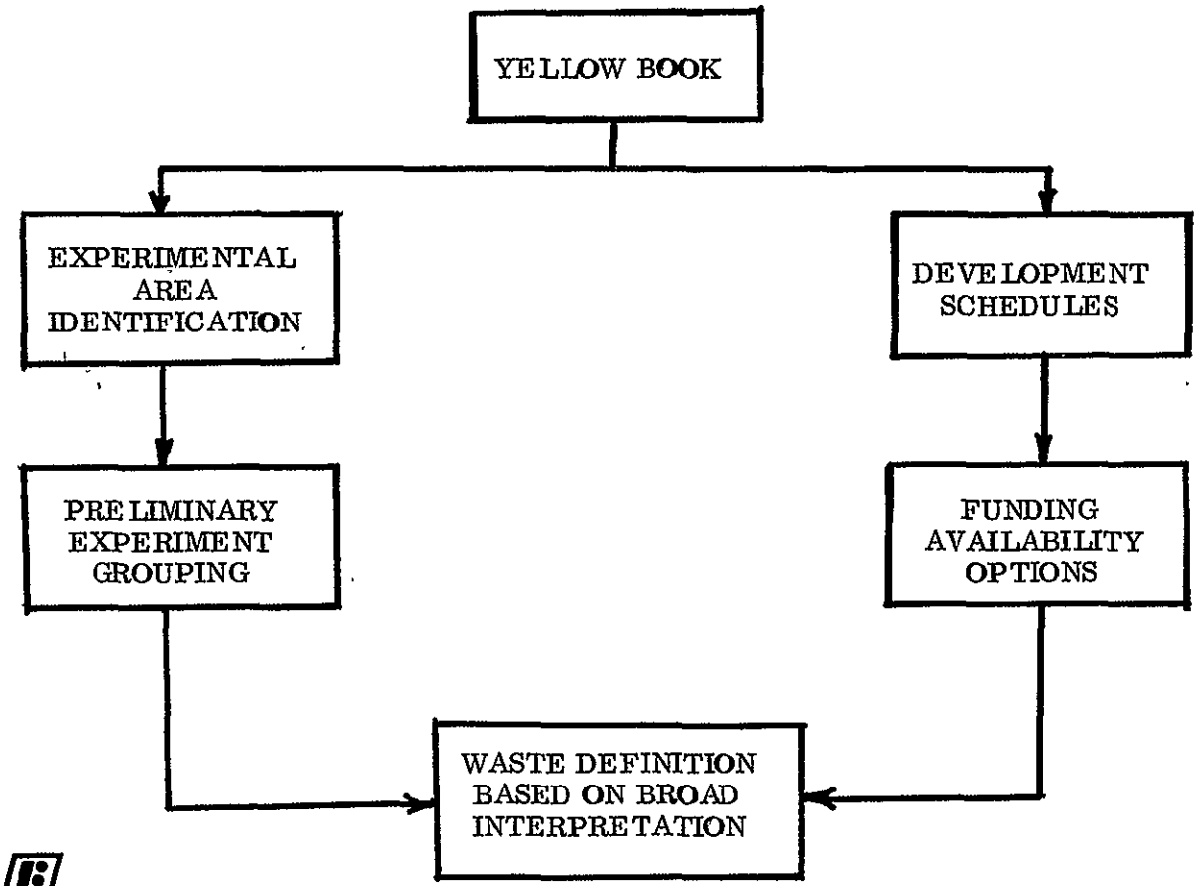
# WASTE DEFINITION DATA RELATIONSHIP TO YELLOW BOOK

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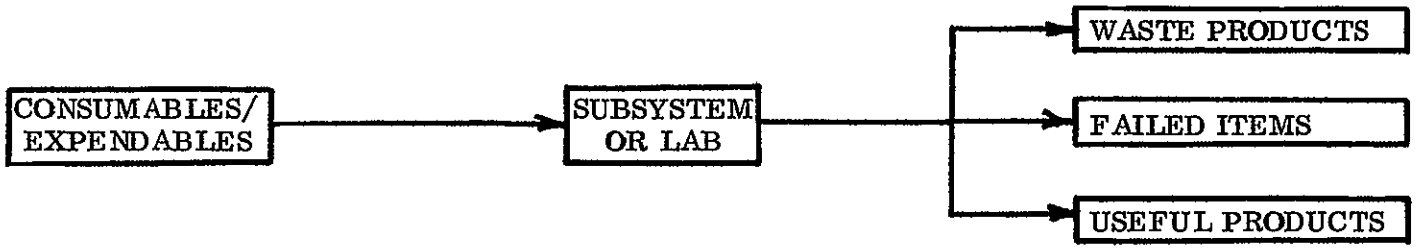
## MATERIAL FLOW RELATIONSHIP TO WASTE DEFINITION

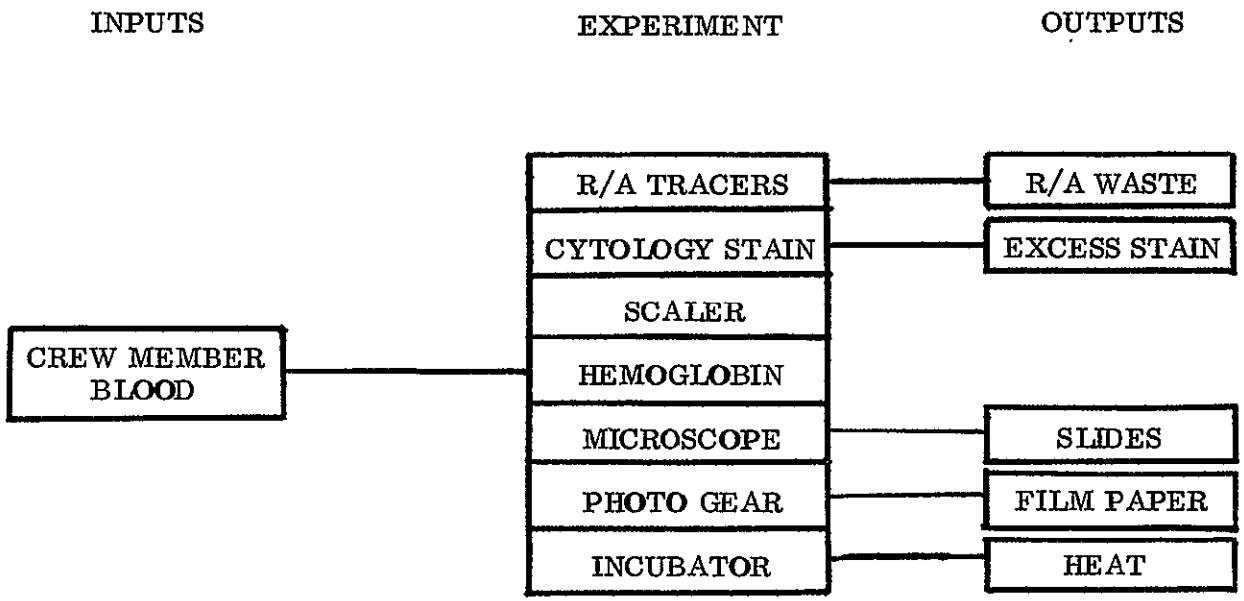



WASTE PRODUCTS FROM SYSTEMS RESULT FROM SCHEDULED MAINTENANCE/CONSUMED AND CLEANABLE ITEMS ARE WASTES.

FAILED ITEMS RESULT FROM UNSCHEDULED MAINTENANCE/FAILURE RATES BASED ON LAMBA T WHERE T = 10 YEARS/MAINTENANCE PERFORMED ON LINE REPLACEABLE UNIT BASIS/PACKAGING FOR REPLACEMENTS PARTS USED FOR RETURN OF FAILED ITEMS.

USEFUL PRODUCTS SUCH AS DATA ITEMS MAY BE RETURNED TO EARTH.

OPERATIONAL DESCRIPTION (SCHEMATIC DIAGRAM)
HEMATOLOGY - BLOOD CELL DYNAMICS




R/A = Radioactive

## RATIONALE

Specific tests are employed in this series to determine the effect of space flight on various blood cells (erythrocyte, leukocyte, and platelet dynamics). A sample of 5 mℓ of blood is required from each crewmember for each of 28 test periods. The grand total of the blood and reagents would be 500 mℓ. Film paper would contribute about 3 pounds of waste overall. The discarded glass slides should approach about 1/2 pound total for the three experiments. The radioactive (R/A) waste would be primarily in the discarded blood. Expected radioactivity would never exceed 1-2 uc of activity due to the quantities required.

## REFERENCES

1. National Multipurpose Space Station, NASA MSC December 1964.

2. Medical Aspects of an Orbiting Research Laboratory, NASA Space Medicine Advisory Group, NASA Report No. SP-86, 1966.

3. Experiment Program For Extended Earth Orbital Missions, Revision No. 1, NASA OMSF, September 1, 1969.

| Consumable/Expendable ITEM | How Consumed | Basic Constituents Consumed | Expt. Total Lbs. | Max. Rate Lbs./Day | Single Load Rate Lbs/Unit | Average Density Lbs/Cu.Ft. | Remarks |
|---|---|---|---|---|---|---|---|
| Film | Exposed | Silver Emulsion | 10.0 | .3 | .3 | 43 | |
| Cytology Stain | Chemical Reaction | Dyes | 3.0 | .1 | .1 | 62 | |
| Glass Slides | Contamination-R/A | Glass | .5 | .02 | .02 | 150-175 | |
| Container | Contamination-R/A | Glass | 2.0 | .06 | .06 | 150-175 | |
| Radioactive Isotopes | Chemical Reaction | $NaI^{131}$ $Na_2Cr^{51}O_4$ | 0.1 | .003 | .003 | 62 | Must be shielded by lead |

| WASTE ITEM | Characteristics State And Condition | Chemical Composition | Action Required To Reclaim | Expt. Total lbs. | Max. Rate lbs/day | Single Load Rate lbs/unit | Average Density lbs/cu.ft | Index Of Utilization Potential And Remarks |
|---|---|---|---|---|---|---|---|---|
| Microscope Slides Glass | Solid Non R/A | $Si O_2$ | Wash | 5 | .2 | .2 | 150-175 | |
| Microscope Slides Glass | Solid R/A | $Si O_2$ | N/R | .5 | .02 | .02 | 150-175 | Protect against R/A contact |
| Cytology Stain | Liquid | $H_2O$ + Stain | N/R | 5 | .2 | .2 | 62 | |
| Film Paper | Solid | C - H - O | N/R | 3 | .1 | .1 | 44-72 | |
| Container | Glass R/A | $Si O_2$ | R/A Decay | 2 | .06 | .06 | 150-175 | Protect against R/A contact |
| Radioactive Isotopes | Liquid | $NaI^{131}$ - $Na_2Cr^{51}$ | None | 0.1 | .003 | .003 | 62 | Must be constantly shielded |

INDUSTRY

McDONNELL DOUGLAS

NORTH AMERICAN ROCKWELL

COLLINS

GRUMMAN

LITERATURE SEARCHES

DEFENSE DOCUMENTATION CENTER

DEFENSE LOGISTICS STUDIES INFORMATION EXCHANGE

NASA LITERATURE TAPES

FH/RAD LIBRARY

FAIRCHILD HILLER

AIRCRAFT PROGRAMS

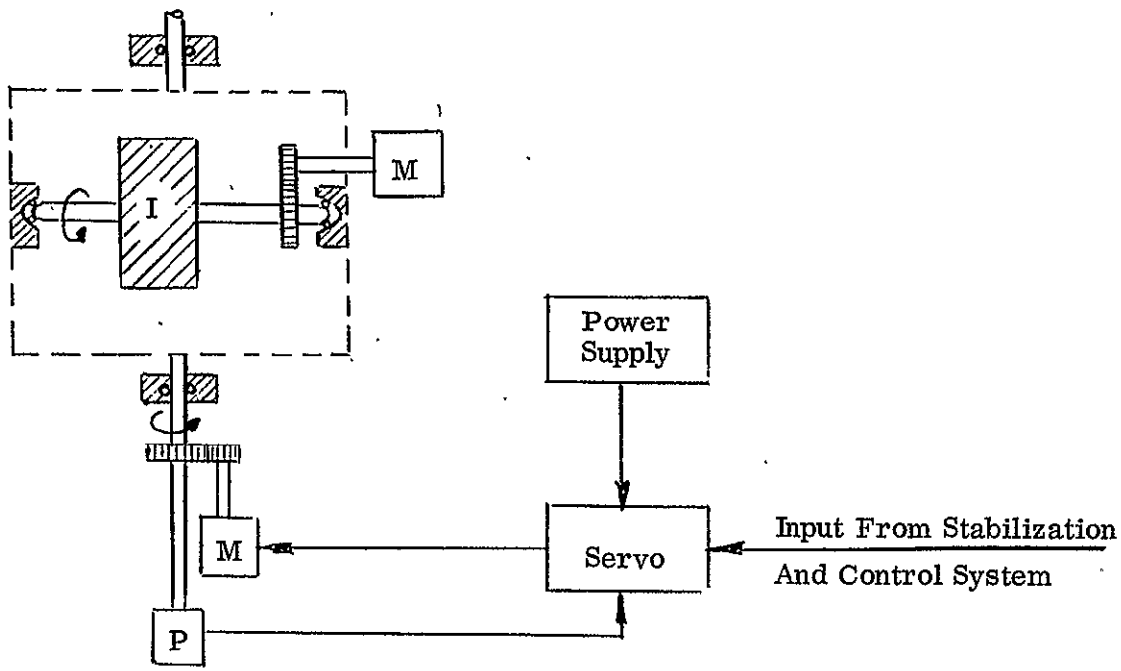
POWER CONVERSION PROGRAMS

APPLICATIONS TECHNOLOGY SATELLITE PROGRAM

SKYLAB WASTE MANAGEMENT

HABITABILITY DEFINITION

- PERSONAL HYGIENE
- FOOD MANAGEMENT
- CREW QUARTERS




Control Moment Gyro System

## RATIONALE

Control Moment Gyros (CMG's) will be used for attitude stabilization of both the space station and space base (Ref. 1). The system comprises three CMG's, oriented in the x, y, and z directions, with associated spin drive motors, gimbals, gimbal angle drive motor and gimbal angle pick-offs. In operation, the gimbal angle is driven off by a servo under control of signals from the stabilization and control system until the disturbance moments are compensated.

The analyses given herewith is based on an assumed gyro wheel weight of 240 pounds. The estimated bearing and motor weights have been sized accordingly and are given in the analysis Table I. If a different size gyro wheel is employed, the weights of bearings and motors may be scaled linearly as a first approximation.

The failure rates employed were obtained from Ref. 2, modified by engineering judgment and combined other sources.

## REFERENCES

1. NASA, Space Station RFP
2. MIL-HDBK-217A (1 December 1965) Reliability Stress and Failure Rate Data for Electronic Equipment

| LRU Part Type | Number of Items | Weight Per Item | Total Weight Pounds | Failure Rate Fails/$10^6$ Hrs | Number of Failures Per Year | Total Weight Per 10 Yrs | Single Load Rate Lbs/Unit |
|---|---|---|---|---|---|---|---|
| CMG Gyro Bearing | 6 | 6 | 36 | 5.2 | 0.274 | 16.4 | 6 |
| CMG Gimbal Bearing | 6 | 6 | 36 | 2.6 | 0.137 | 8.2 | 6 |
| CMG Drive Motor | 3 | 50 | 150 | 7.5 | 0.187 | 93.5 | 50 |
| CMG Gimbal Angle Pick-Off | 3 | 1 | 3 | 7.0 | 0.184 | 1.8 | 1 |
| CMG Servo Electronics | 3 | 15 | 45 | 11.0 | 0.289 | 43.4 | 15 |
| CMG Gimbal Angle Servo Motor | 3 | 25 | 75 | 7.5 | 0.187 | 46.8 | 25 |
| CMG Power Supply | 1 | 15 | 15 | 14.0 | 0.123 | 18.5 | 15 |

CONSUMABLES/EXPENDABLES
STABILIZATION AND CONTROL SUBSYSTEM

| Consumable/Expendable Item | How Consumed | Basic Constituents Consumed | Ten Year Total Lbs. | Max. Rate Lbs/Day | Single Load Rate Lbs/Unit | Average Density Lbs/Cu. Ft. | Remarks |
|---|---|---|---|---|---|---|---|
| Spare CMG Gyro Bearing | Part Failure | Component Part | 16.4 | - | 6 | 250 | RTE |
| Spare CMG Gimbal Bearing | Part Failure | Component Part | 18.2 | - | 6 | 250 | RTE |
| Spare CMG Drive Motor | Part Failure | Component Part | 93.5 | - | 50 | 200 | RTE |
| Spare CMG Gimbal Angle | Part Failure | Component Part | 1.8 | - | 1 | 200 | RTE |
| Spare CMG Servo Electronics | Part Failure | Component Part | 43.4 | - | 15 | 52 | RTE |
| Spare CMG Gimbal Angle Servo Motor | Part Failure | Component Part | 46.8 | - | 25 | 200 | RTE |
| Spare CMG Power Supply | Part Failure | Component Part | 18.5 | - | 15 | 77 | RTE |
| Packaging For Replacement Parts | Environmental Integrity Destroyed | Internal Environment Changed | - | - | - | 5 | Reuse for Returning Failed Items |

RTE - Return to Earth

| WASTE ITEM | Characteristics State And Condition | Chemical Composition | Action Required To Reclaim | Ten Year Total lbs. | Max. Rate lbs/day | Single Load Rate lbs/unit | Average Density lbs/cu.ft | Index Of Utilization Potential And Remarks |
|---|---|---|---|---|---|---|---|---|
| 1. Failed CMG Gyro Bearing | Solid Metal RTE | Fe | Repair | 16.4 | - | 6 | 250 | |
| 2. Failed CMG Gimbal Bearing | Solid Metal RTE | Fe | Repair | 8.2 | - | 6 | 250 | |
| 3. Failed CMG Drive Motor | Solid Metal RTE | Cu, Fe | Repair | 93.5 | - | 50 | 200 | .2 Repair on board |
| 4. Failed CMG Gimbal Angle Pick-Off | Solid Metal RTE | Cu, Fe | Repair | 1.8 | - | 1 | 200 | .2 Repair on board |
| 5. Failed CMG Servo Electronics | Solid Metal RTE | Al, Cu, Fe, Si | Repair | 43.4 | - | 15 | 52 | .2 Repair on board |
| 6. Failed CMG Gimbal Angle Servo Motor | Solid Metal RTE | Cu, Fe | Repair | 46.8 | - | 25 | 200 | .2 Repair on board |
| 7. Failed CMG Power Supply | Solid Metal RTE | Al, Cu, Fe, Si | Repair | 18.5 | - | 15 | 77 | .2 Repair on board |
| 8. Packaging for Replacement Parts | Solid Plastic RTE | Plastic Sponge and Sheeting | Reuse As Is | - | - | - | 5 | |

## WASTE UTILIZATION/RECOVERY PROCESS CATEGORIES

PHYSICAL SEPARATION

- Filtration
- Centrifugation
- Thermal
- Vacuum
- Distillation
- Absorption (Molecular Sieve)

ELECTROLYSIS (Water)

OXIDATION

- Incineration
- Wet (Zimmerman Process)

DECOMPOSITION

- Thermal (Pyrolysis)
- Bacterial (Aerobic/Anaerobic)

REDUCTION ($CO_2$)

- Bosch Process
- Sabatier Process
- Solid Electrolyte Process

COMPACTION

PROPULSION

FOOD PREPARATION

FUNCTIONS:

1) Regenerate original material
2) Produce useful intermediate (consumable)
3) Provide useful spacecraft functions by ejection or storage.

## SAMPLE WASTE UTILIZATION/RECOVERY PROCESS DATA SUMMARY

PROCESS NAME - Wet Oxidation

PROCESS BASIS/PRINCIPAL - Elevated temperature and pressure oxidation of aqueous slurries or solutions of organic materials.

MATERIALS TREATED -
1) Raw urine and/or feces
2) Urine distillation residue
3) Cellulose, sucrose, etc.
4) Proteins, amino acids

CONSUMABLES REQUIRED - $O_2$

PRODUCTS - $CO_2$, $H_2O$, $N_2$, $NH_4$ salts, $CH_3COOH$, White ppt. in aqueous phase

PROCESS DATA -
1) Nominal T, P: 500°F, 2300 psi
2) Thermal requirements - ca. 250 BTU/lb.
3) Conversion efficiency - 95% (organic)

UTILITY -
1) Deactivation of complex organic wastes (including biological)
2) Closure of carbon balance (in conjunction with $CO_2$ reduction)
3) Generation of plant nutrition media through lower level (partial) oxidation

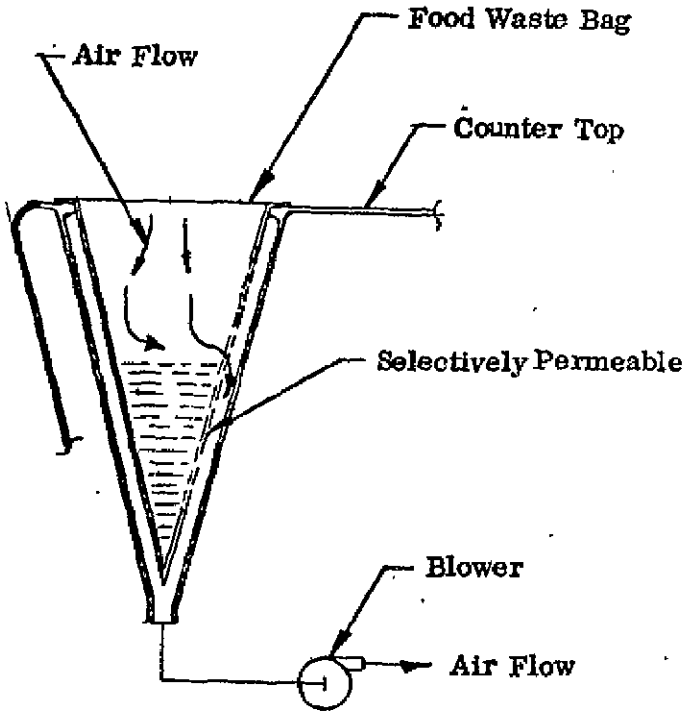
REFERENCES -
1) "Investigation of the Feasibility of Wet Oxidation For Spacecraft Waste Treatment" - R.B. Wheaton et al. NASA CR66450, 1967.
2) "Wet Oxidation For Space Waste Management" - J. Konikoff and T. Slawecki, SAE Paper 680714, October 1968.
3) "The Problems of the Possibility of the Mineralization of Water - Fecal Mixtures by the Method of Wet Burning" - A.L. Agre et al. NASA TT 66-34698, October 1966.

## MICROBIAL CONTROL

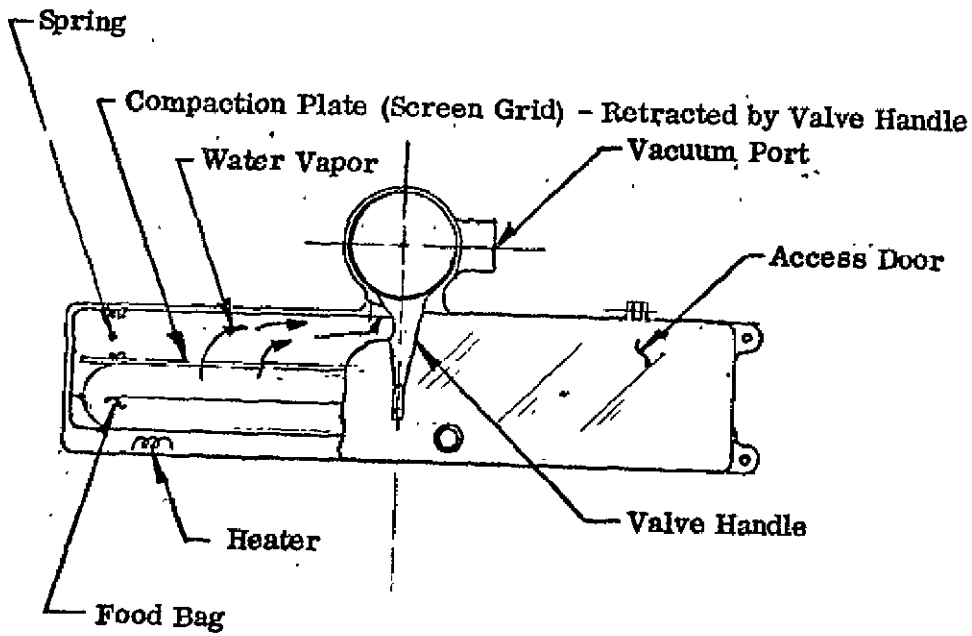
INCINERATION
HOT AIR STERILIZATION
DESICCATION (DEHYDRATION)
GAMMA RAY IRRADIATION
MOIST HEAT STERILIZATION (AUTOCLAVE)

## COMPACTION

BAG TYPE DRYER/COMPACTOR
CENTRIFUGAL DRYER/COMPACTOR
CENTRIFUGAL SHREDDER
BELLOWED COMPACTOR/CONTAINER




COLLECTION




DRYING AND COMPACTING

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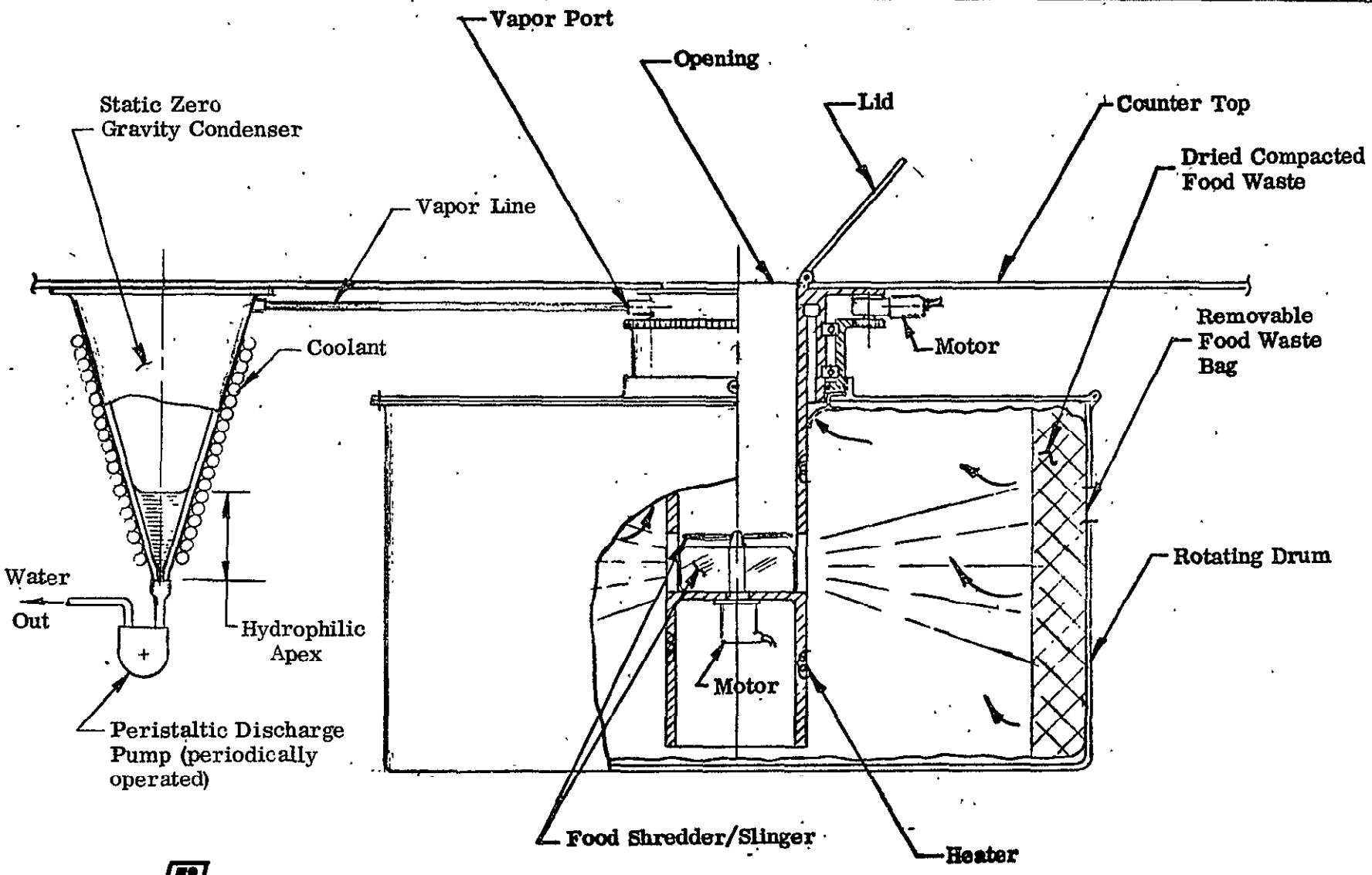
CENTRIFUGAL FOOD WASTE DRYER/COMPACTOR

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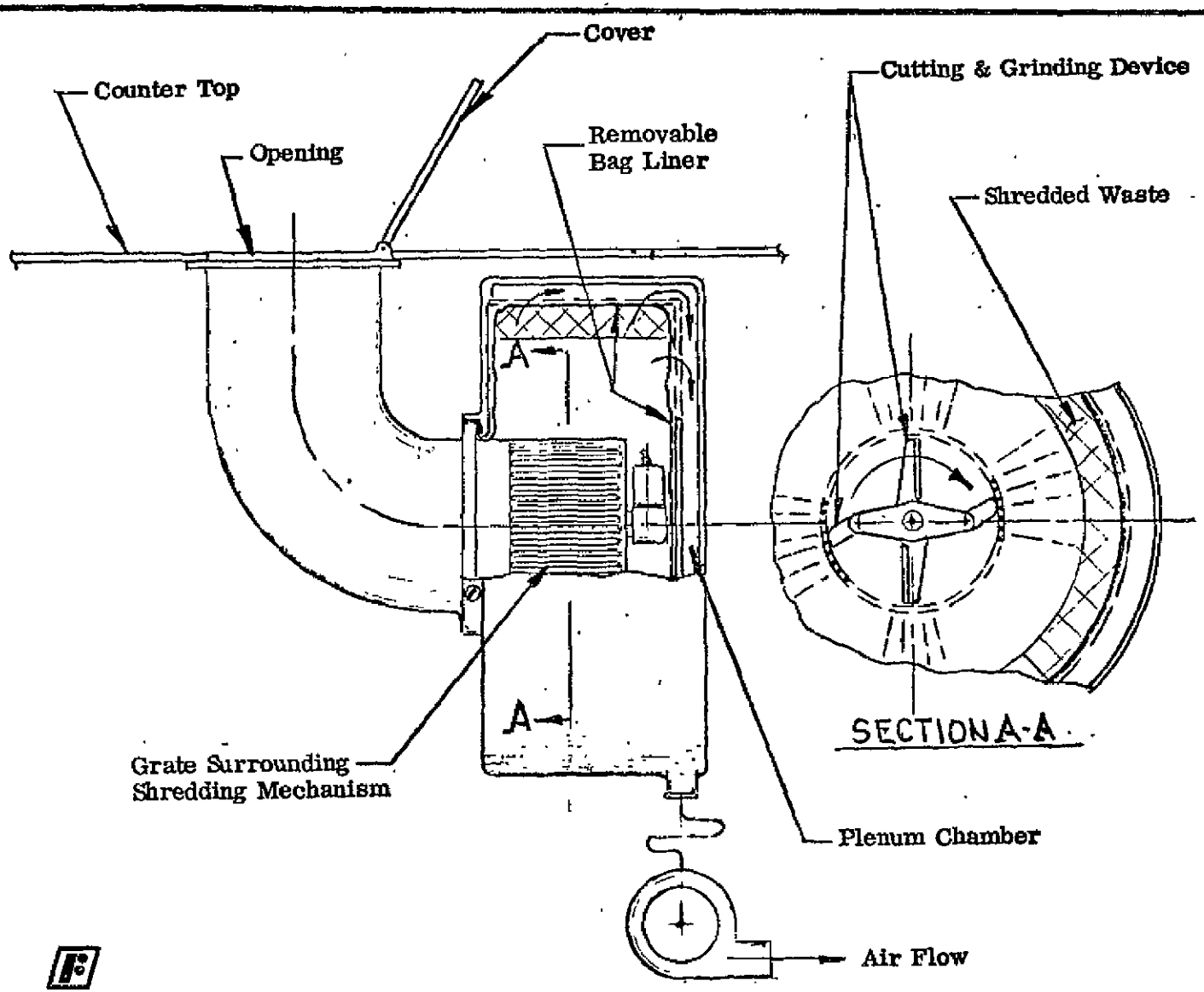


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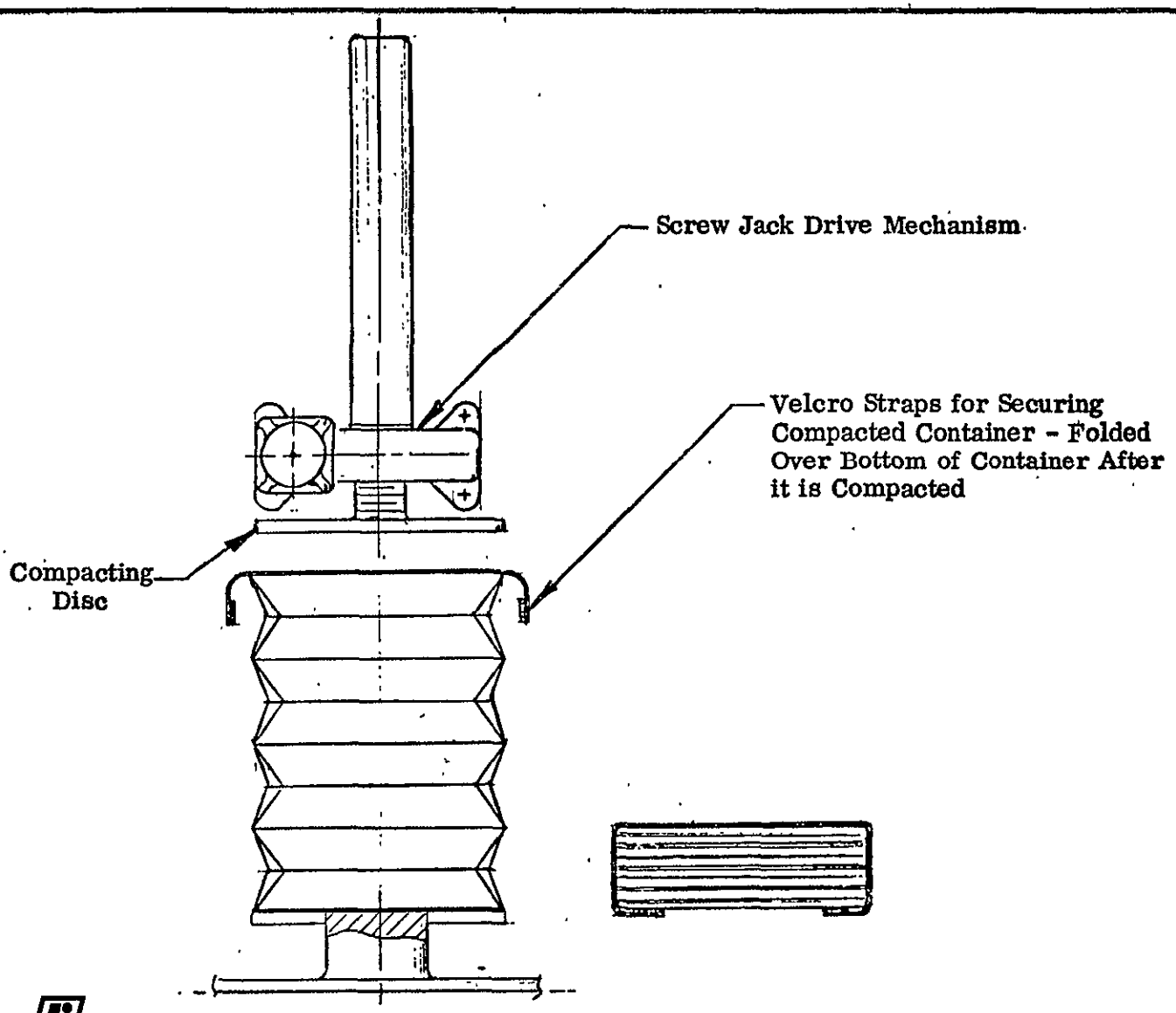
# BELLOWED COMPACTOR/CONTAINER

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FARMINGDALE, NEW YORK 11735

A. JETTISON TO EARTH ATMOSPHERE FOR AERODYNAMIC INCINERATION AND DISPERSION

1. VIA ROCKET PROPULSION

2. VIA SHUTTLE

B. JETTISON TO PARKING ORBIT

1. VIA ROCKET PROPULSION

2. VIA SHUTTLE

C. JETTISON TO SOLAR ORBIT VIA ROCKET PROPULSION

D. RETURN TO EARTH VIA SHUTTLE

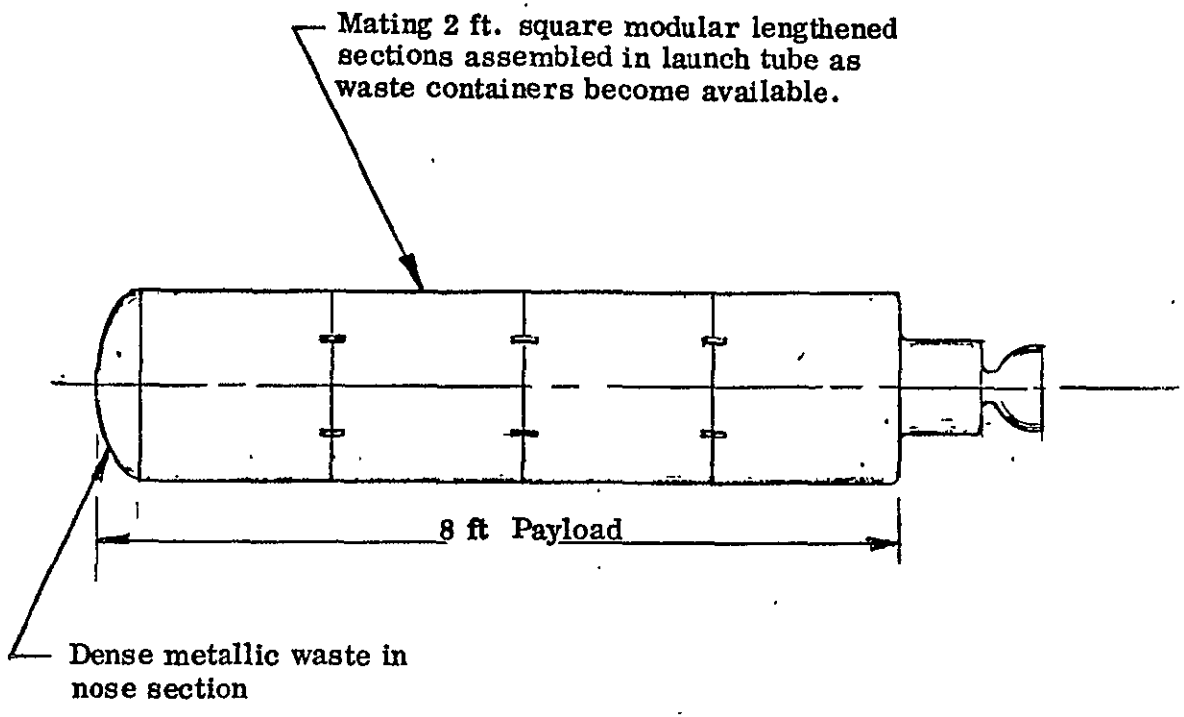
E. ON BOARD STORAGE

F. JETTISON TO REMOTE MODULE

1. VIA AUTOMATIC MANEUVERING UNIT

2. VIA MANNED MANEUVERING UNIT

ROCKET FOR JETTISON TO EARTH ATMOSPHERE OF
1250 LBS. COMPACTED WASTE FROM 300 N.M. ORBIT




Fuel required: $W_p = .052\ W_w = .052\ (1250\#) = 65\#$

Rocket Struct: $W_s = .0071\ W_w = .0071\ (1250\ ) = 9\#$

Propulsion system Wt = 74#

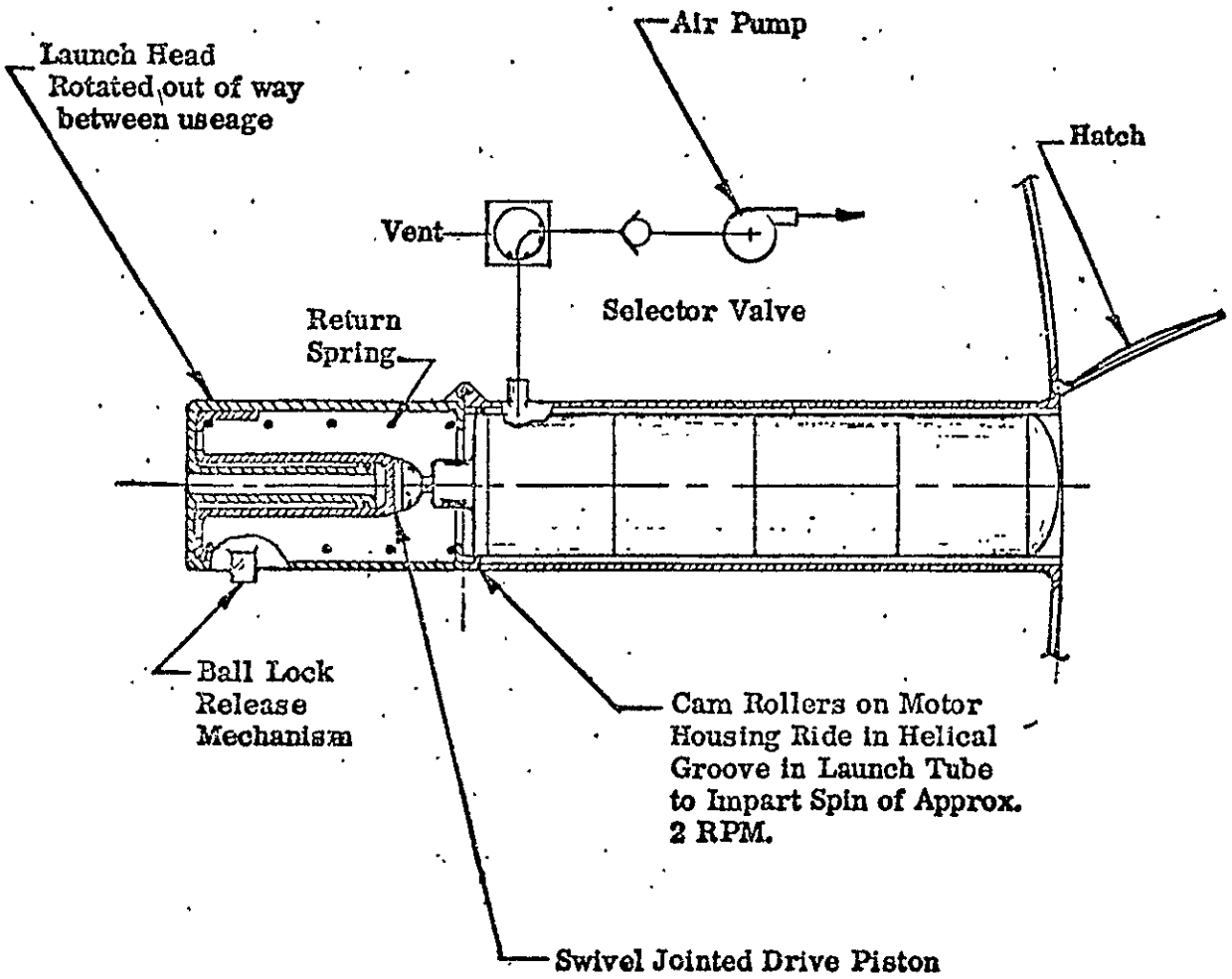
Total required impulse $= I W_p = 260 \frac{\#\ sec}{\#} (65\#) = 16,900\#$ sec.

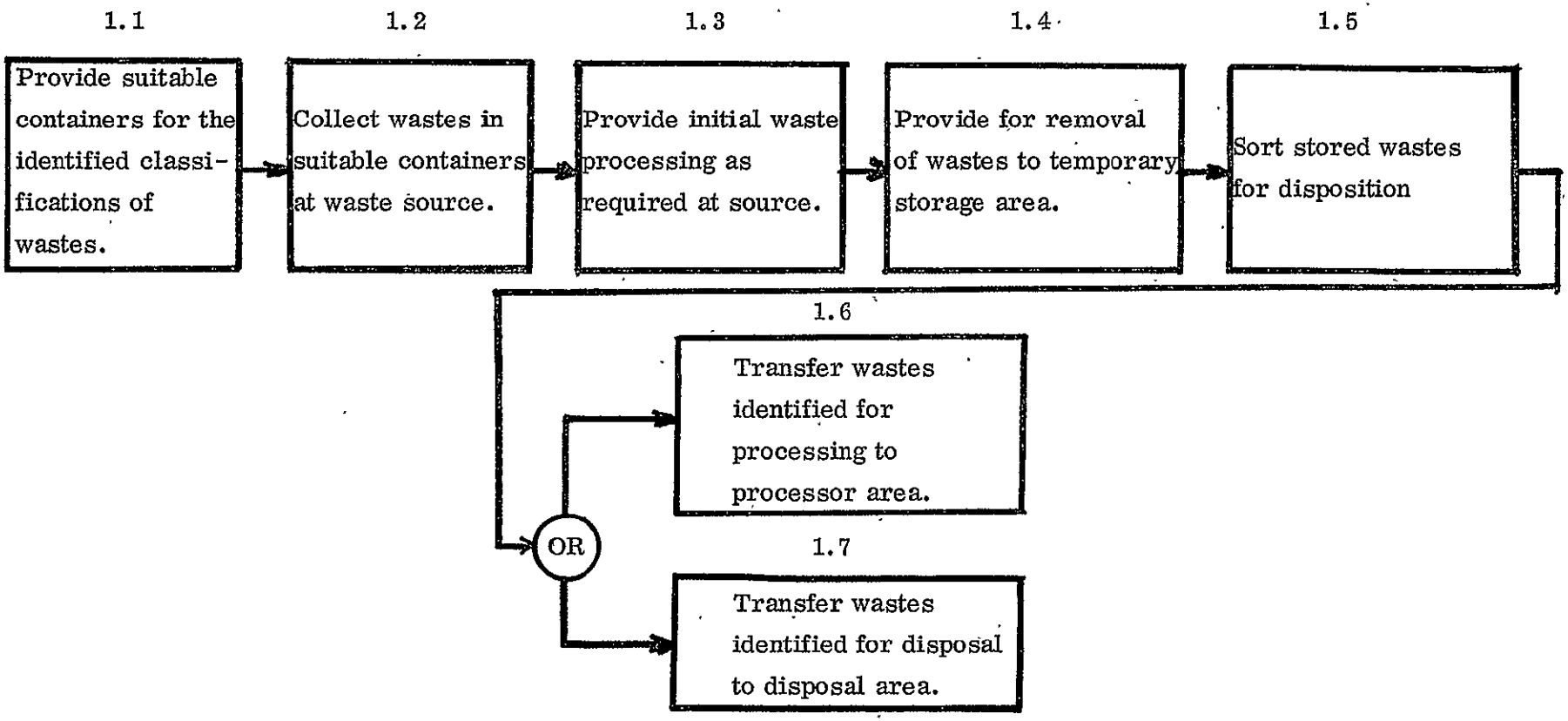
Fuel Vol $= 65\ \# \div 107 \frac{\#}{ft^3} = .61\ ft^3$

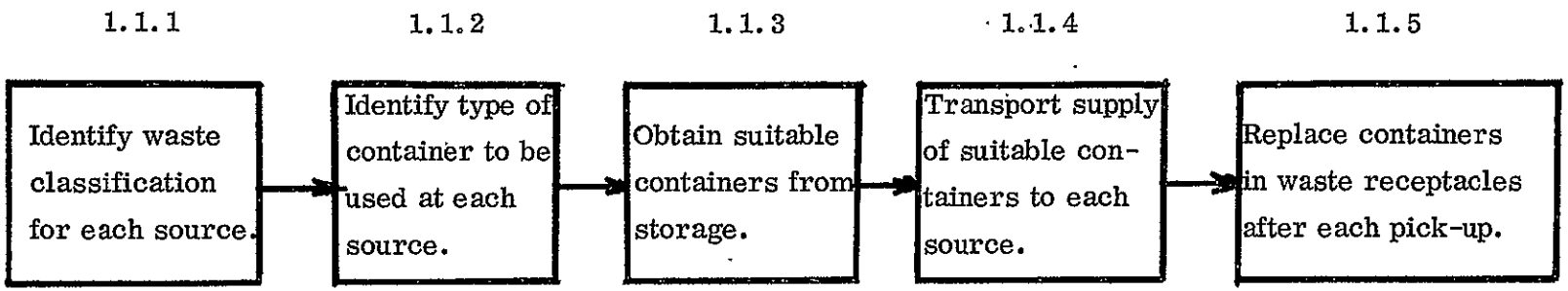
# CONFIGURATION FOR SPIN EJECTING WASTE ROCKET

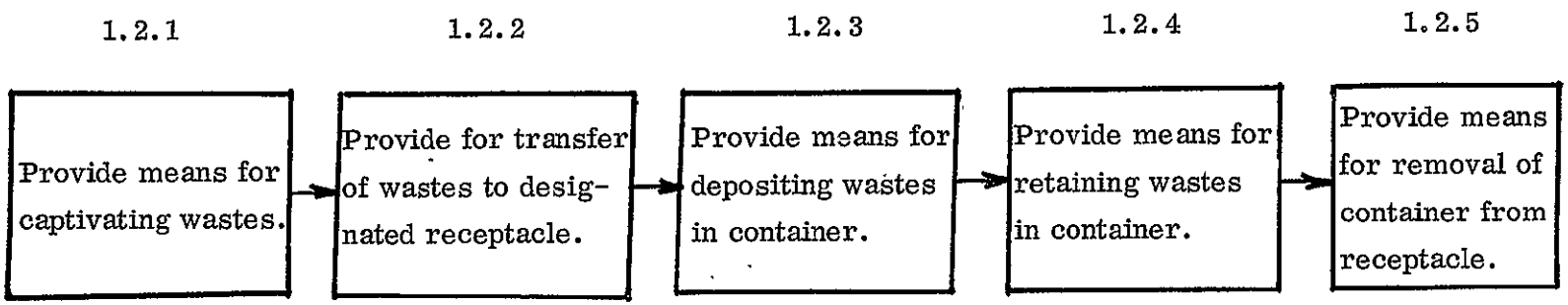
OPERATION:

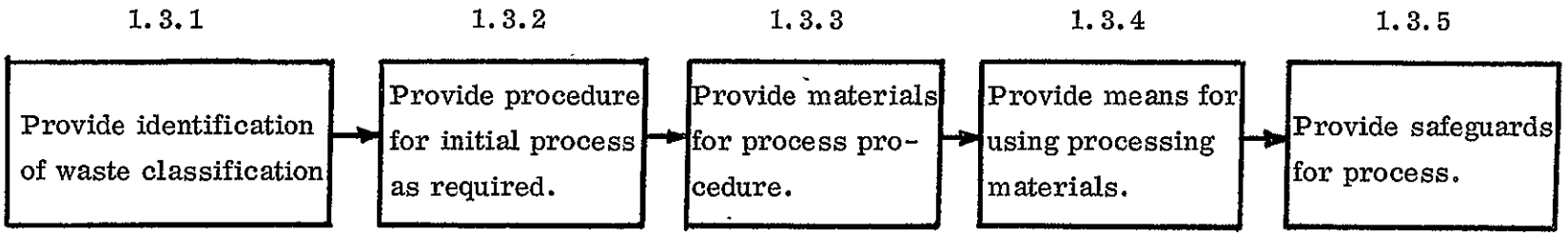
1. Pump down launch tube to conserve air and open hatch.
2. Release ball-lock mechanism; atmospheric pressure acting on launch piston ejects rocket.
3. Close hatch.
4. Vent launch tube-spring in launch mechanism retracts launch piston.



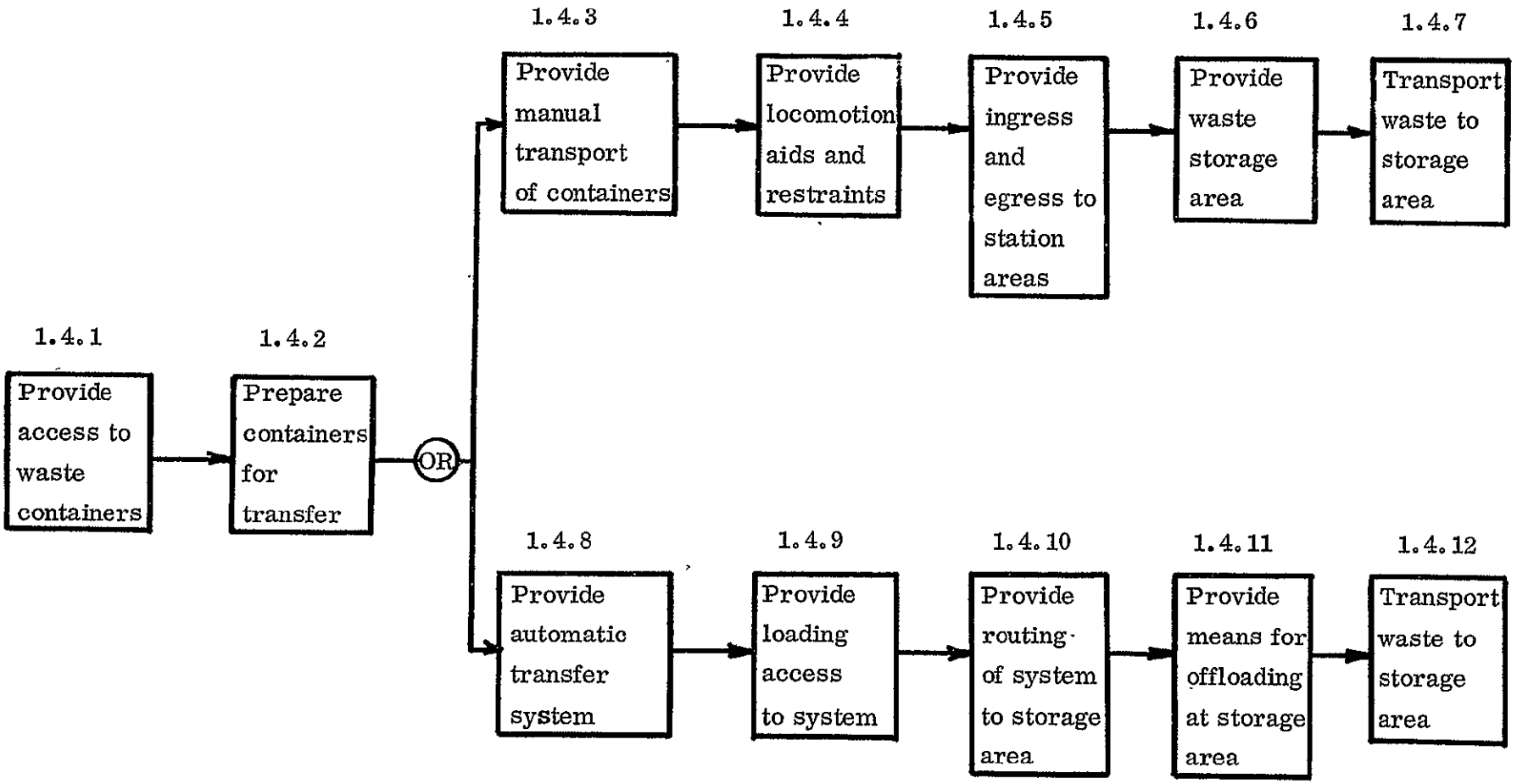

1.1
Provide suitable containers for the identified classifications of wastes.
1.2
Collect wastes in suitable containers at waste source.
1.3
Provide initial waste processing as required at source.
1.4
Provide for removal of wastes to temporary storage area.
1.5
Sort stored wastes for disposition
1.6
Transfer wastes identified for processing to processor area.
OR
1.7
Transfer wastes identified for disposal to disposal area.


1.1.1
Identify waste classification for each source.
1.1.2
Identify type of container to be used at each source.
1.1.3
Obtain suitable containers from storage.
1.1.4
Transport supply of suitable containers to each source.
1.1.5
Replace containers in waste receptacles after each pick-up.

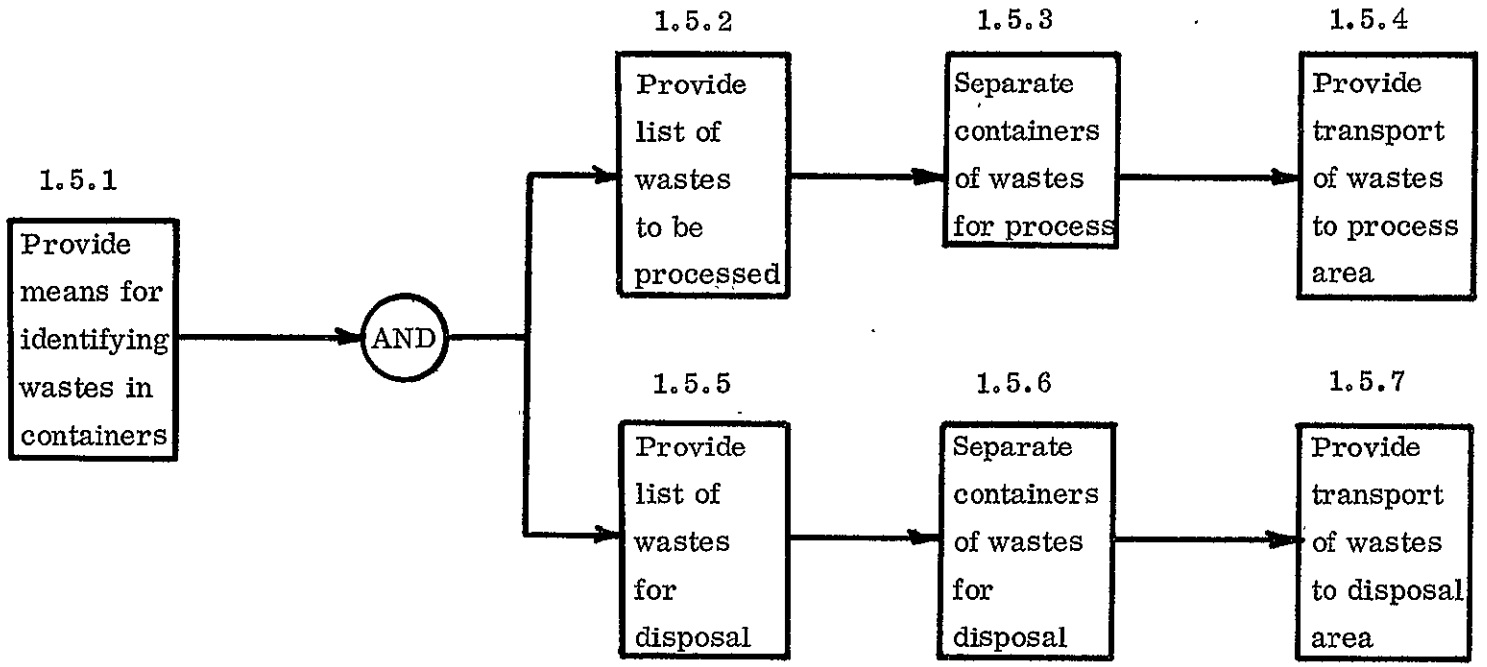

1.2.1
Provide means for captivating wastes.
1.2.2
Provide for transfer of wastes to designated receptacle.
1.2.3
Provide means for depositing wastes in container.
1.2.4
Provide means for retaining wastes in container.
1.2.5
Provide means for removal of container from receptacle.


1.3.1
Provide identification of waste classification
1.3.2
Provide procedure for initial process as required.
1.3.3
Provide materials for process procedure.
1.3.4
Provide means for using processing materials.
1.3.5
Provide safeguards for process.

FUNCTION 1.4 PROVIDE FOR TRANSFER OF WASTES



FUNCTION 1.5 PROVIDE SORTING OF WASTES FOR DISPOSITION



| | CONCEPT | DESIGN CONSIDERATIONS |
|---|---|---|
| 1. | CENTRAL VACUUM | OUTLETS AT EACH AREA/CLOSURES/CONDUITS/CENTRAL COLLECTION/ CENTRAL VACUUM POWER SOURCE |
| 2. | PNEUMATIC TUBE | INDIVIDUAL TUBES TO EACH AREA/WASTE CONTAINER SHUTTLES/ PREPARATION/MAINTENANCE ACCESS/PNEUMATIC POWER SOURCE/ OPENING SEALS |
| 3. | LIQUID | PLUMBING/PUMPS/TANKS/LIMITED UTILITY |
| 4. | CABLE RUNS | BULKHEAD PENETRATION/MAINTENANCE ACCESS/LOADING/MANUAL POWER/MOTIVE POWER |
| 5. | VELCRO BELTS | BULKHEAD PENETRATION/POWER DRIVES/MAINTENANCE ACCESS/ MANUAL LOADING/CONTAINER ADAPTATION FOR VELCRO PADS |

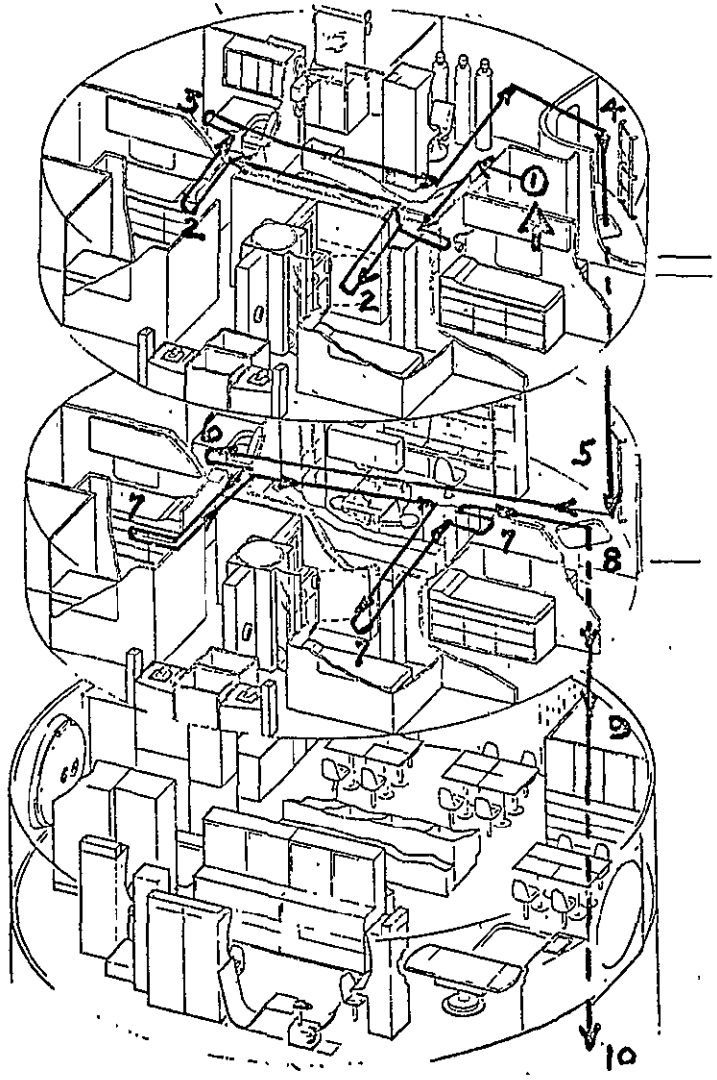
| WASTE CONDITION / WASTE STATE | NON-TOXIC, STERILE, OR INERT | TOXIC, PATHOGENIC, OR ACTIVE | HOT (ABOVE SAFE SKIN CONTACT TEMPERATURE) | COLD (BELOW SAFE SKIN CONTACT TEMPERATURE) | RADIOACTIVE |
|---|---|---|---|---|---|
| A. SOLID | SOFT BAG | SEALED IMPERMEABLE BAG | INSULATED CONTAINER | INSULATED CONTAINER | SHIELDED CONTAINER |
| B. LIQUID | SOFT BAG | SEALED IMPERMEABLE BAG | INSULATED CONTAINER | INSULATED CONTAINER | SHIELDED CONTAINER |
| C. GAS | FLASK | FLASK | FLASK IN INSULATED CONTAINER | FLASK IN INSULATED CONTAINER | FLASK IN SHIELDED CONTAINER |
| D. MIXTURE - Solid and Liquid | SOFT BAG | SEALED IMPERMEABLE BAG | INSULATED CONTAINER | INSULATED CONTAINER | SHIELDED CONTAINER |
| E. MIXTURE - Liquid and Gas | FLASK | FLASK | FLASK IN INSULATED CONTAINER | FLASK IN INSULATED CONTAINER | FLASK IN SHIELDED CONTAINER |

TRANSFER CONTAINER DATA

| CANDIDATE CONTAINERS | CONTAINER LIMITATIONS | | |
|---|---|---|---|
| | VOLUME (CU.FT.) | DIAMETER (INCHES) | GROSS WEIGHT (LOADED - LBS) |
| BAG | 5.3 | 18 | 35 |
| SEALED BAG | 5.3 | 18 | 35 |
| INSULATED CONTAINER | 1.5 | 12 | 35 |
| SHIELDED CONTAINER | 1.0 | 12 | 35 |
| FLASK | 0.5 | 12 | 35 |

| CONTAINER | HORIZONTAL HRS/FT $\times 10^{-3}$ | VERTICAL HRS/FT $\times 10^{-3}$ | TURN HRS/TURN $\times 10^{-3}$ | AIRLOCK HRS/PASSAGE $\times 10^{-3}$ | HATCH HRS/PASSAGE $\times 10^{-3}$ |
|---|---|---|---|---|---|
| BAG | 0.092 | 0.139 | 1.11 | 35.0 | 12.5 |
| SEALED BAG | 0.092 | 0.139 | 1.11 | 35.0 | 12.5 |
| INSULATED CONTAINER | 0.139 | 0.185 | 0.84 | 32.5 | 11.2 |
| SHIELDED CONTAINER | 0.139 | 0.185 | 0.84 | 32.5 | 11.2 |
| FLASK | 0.139 | 0.185 | 0.84 | 32.5 | 11.2 |

# TYPICAL WASTE HANDLING ROUTING AND TASKS



1. Start at Deck 3 crew quarters.
2. Remove soiled clothing in crew quarters.
3. Remove soiled clothing from Chief Investigator's Stateroom.
4. Enter inter-volume airlock.
5. Pass through airlock to Deck 2.
6. Remove soiled clothing from Commander's stateroom.
7. Remove soiled clothing from crew quarters.
8. Leave Deck 2 by auxiliary hatch.
9. Pass through Deck 1 and enter storage area in torus.
10. Store soiled clothing for laundering.

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REPUBLIC AVIATION DIVISION
FARMINGDALE, NEW YORK 11735

## DATA PROCESSING PROGRAM - OBJECTIVES

- COLLECT CONDENSED DATA AND STORE IN PERMANENT DISC STORAGE FILES.

  Waste Material Generation

  Properties/Attributes

  Associated Handling Equipment And Procedures

  Utilization And Disposal Processes

- PERMIT KEYWORD ORIENTED SEARCHES OF DATA.

- PROVIDE CAPABILITY OF UPDATING OF FILES.

- PREPARE REPORT MATERIAL FROM DATA FILES.

## DATA PROCESSING PROGRAM - DATA CATEGORIES

### WASTE GENERATION/PROPERTIES

* * Waste Name
* * S/C Origin
  Generation Rates
* * State
* * Attributes
* * Composition
  Density
  Unit Weight
  References

### HANDLING

Containers
* * Type
* * Waste Attributes Required
  Design Criteria

Collection Procedures
* * Name
* * Waste Attributes Required
  Containers Required
  Manpower

Transfer Method
* * Name
* * Waste Attributes
  Containers
  Manpower

### PROCESSES

* * Name
* * Input Material
* * Output Material
* * Consumables
  Process Variables
    Electrical
    Thermal
    Manpower
    Equipment
  References

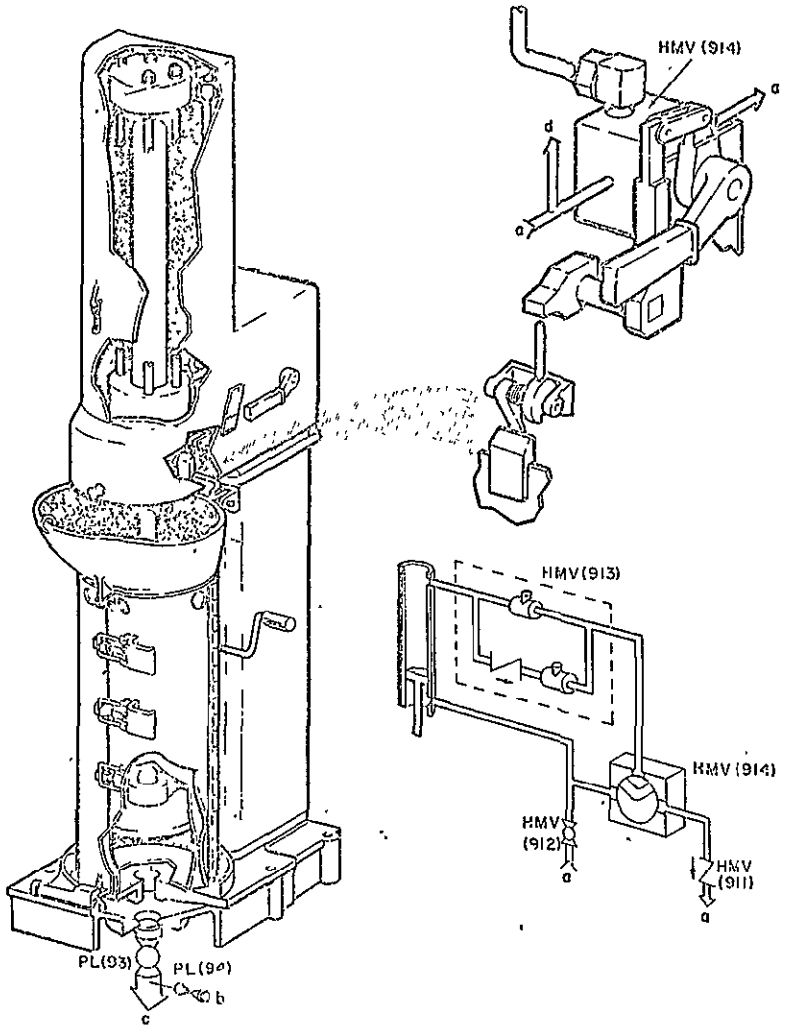
### DISPOSAL

* * Name
* * Waste Attributes
* * Processes Required
* * Consumables
  Manpower/Handling
  Design Constraints

* * Items containing search keywords

## SUBMARINE USS GATO (SSN 615) RELATIONSHIPS TO MANNED SPACE HABITABILITY

| | | |
|---|---|---|
| USS GATO TYPE | - | SMALL/NUCLEAR POWERED/100 MAN/ADVANCED GEAR/ANTISUB |
| UPKEEP CONDITION | - | MINIMUM HOUSEKEEPING |
| OPERATING CONDITION | - | SKILL AND DISCIPLINE PARAMOUNT/HOUSEKEEPING WHEN CONVENIENT |
| RANK | - | VERY IMPORTANT |
| CREW AREAS | - | NUCS CRAMMED/CHIEFS SPACIOUS/OFFICERS TIDY |
| WORK AREAS | - | HIGHLY ENGINEERED |
| AIR REGEN SYSTEM | - | CRITICAL |
| GALLEY | - | SMALL/RUGGED/BULK BINS/ELECTRIC MIXERS, OVENS, AND RANGES |
| PANTRY/FREEZER | - | LARGE/ADJACENT TO RADIATION AREA |
| MESS | - | DINER BOOTH ARRANGEMENT |
| WARD ROOM | - | IMPECCABLE/PANELED/RED LEATHER/FINEST LINEN AND SILVER |
| HEADS | - | RUGGED GEAR/WASTE HOLDING TANKS |
| WASTE CONTAINERS | - | METAL CANS/PLASTIC NET BAGS |
| COMPACTORS | - | ON FBM SUBS |
| TRASH DISPOSAL UNIT | - | IN GALLEY/COMPLEX PROCEDURE AND EQUIPMENT |

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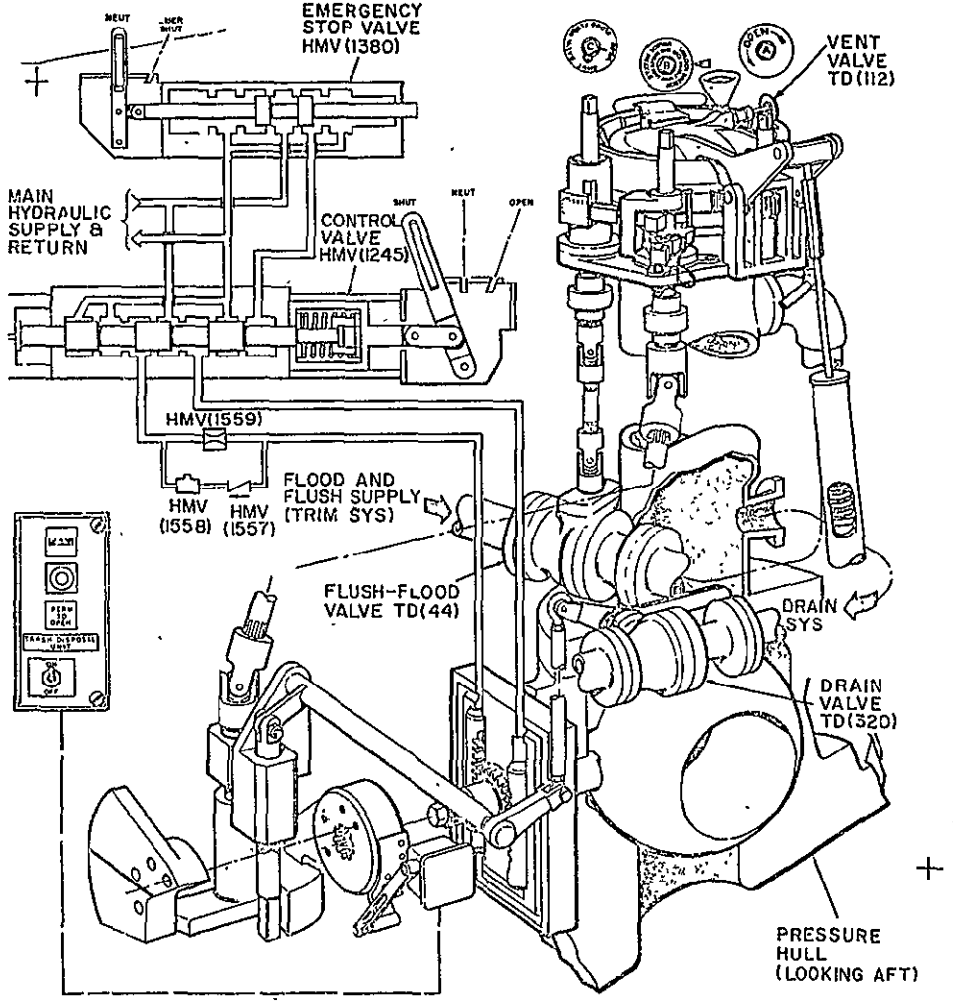
# SUBMARINE TRASH DISPOSAL UNIT ARRANGEMENT




OPERATIONS COMPARTMENT

FAIRCHILD HILLER
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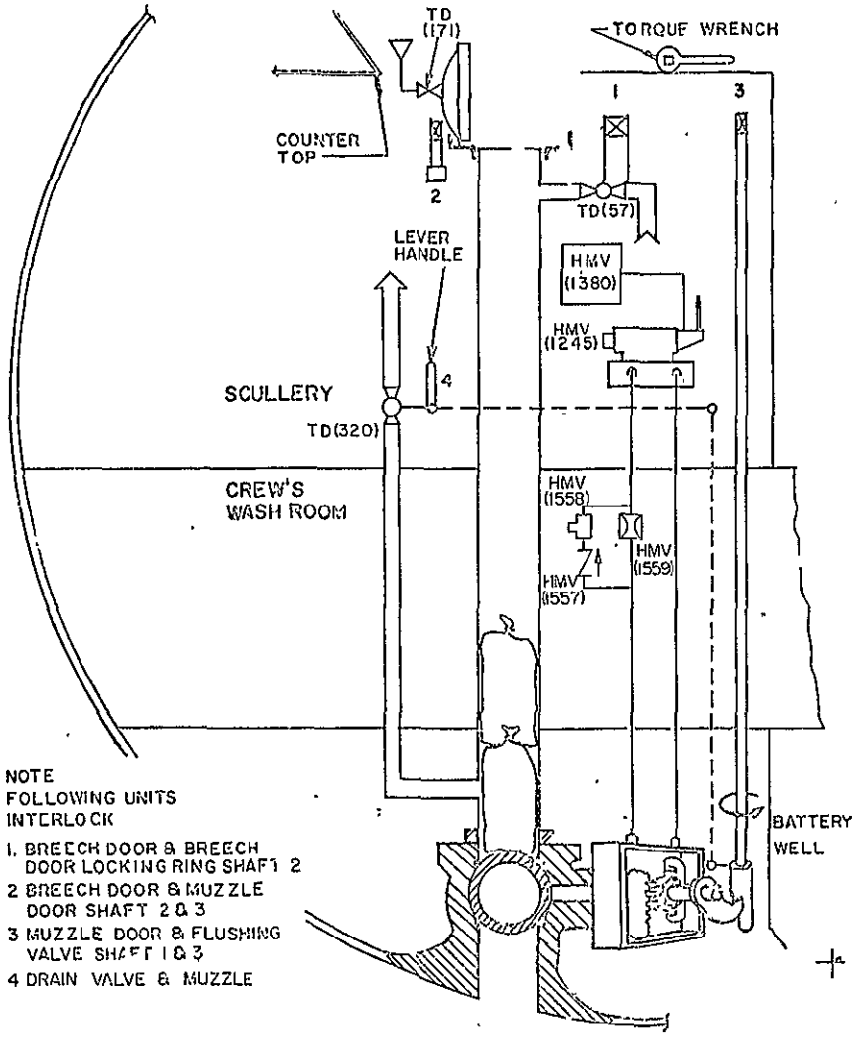
# SUBMARINE TRASH DISPOSAL UNIT LOADING

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A. LOADING THE TDU

1. MAN THE PHONES TO DRAIN MANIFOLD, AIR REGEN, GALLEY, AND CONTROL
2. REQUEST PERMISSION TO LOAD
3. CHECK TDU LINE-UP
4. WHEN ORDERED "LOAD THE TDU"
   a. HOLD A COFFEE MUG OVER VENT
   b. OPEN TDU VENT
   c. UNLOCK BREECH
   d. OPEN BREECH
   e. ADD WATER
   f. LOAD
   g. SHUT BREECH
   h. LOCK BREECH
5. REPORT "TDU LOADED"

B. FLUSHING THE TDU

1. WHEN ORDERED "MAKE THE TDU READY FOR FLUSHING"

   a. OPEN FLUSH VALVE

   b. SHUT TDU VENT

   c. OPEN MUZZLE DOOR

   d. REPORT "MUZZLE DOOR IS OPEN"

   e. DIRECT AIR REGEN TO SHUT ECS ASW DISCHARGE VALVE

   f. FLUSH FOR 3 MINUTES

   g. DIRECT AIR REGEN TO OPEN ECS ASW DISCHARGE VALVE

   h. SHUT FLUSH VALVE

   i. SHUT MUZZLE DOOR

   j. REPORT "THE MUZZLE DOOR IS SHUT"

C. DRAINING THE TDU

1. WHEN MUZZLE DOOR HAS BEEN SHUT

   a. OPEN TDU DRAIN

   b. REQUEST CONTROL TO INFORM DRAIN MANIFOLD OPERATOR "PUMP DOWN THE TDU"

   c. WHEN RECEIVING THE WORD "THE DRAIN PUMP IS RUNNING" OPEN THE TDU VENT

   d. CONTINUE PUMPING UNTIL SUCTION IS LOST

   e. SHUT THE DRAIN PUMP VALVE AND SECURE THE DRAIN PUMP

   f. SHUT THE TDU VENT

   g. REPORT "TDU SECURED, RIGGED FOR DIVE"

2. WHEN NOTIFIED BY CONTROL, SECURE THE PHONES

D. ABNORMAL OPERATIONS

1. IF MUZZLE DOOR FAILS TO SHUT

   a. REPEAT FLUSH

   b. TRY 700 PSIG AIR

   c. PUT DIVER OVERBOARD TO CLEAR MUZZLE

2. IN EVENT OF FLOODING CASUALTY CLOSE MUZZLE DOOR FROM TORPEDO ROOM FLOOD CONTROL STATION OUTSIDE LAUNDRY ROOM

VOLUME VIII - HOUSEKEEPING HANDBOOK

(WASTE DEFINITION AND CONTROL SECTION IN LIEU OF DATA BOOK, DRL LINE ITEM 4)

A. TITLE SHEET

B. FORWARD

C. TABLE OF CONTENTS

D. INTRODUCTION AND SUMMARY

E. CONDUCT OF STUDY

F. STUDY DATA
(Basic Content of Section - See Page 56)

G. DEFINITIONS

H. ABSTRACT

F. STUDY DATA

1. Waste Definition
   a. Discussion (Summary and Organization of Section)
   b. Spacecraft Functions and Systems (Tables of Functional Analyses)
   c. Data Tables (Contains Operational Descriptions and Tables of Consumables/Expendables and Wastes)
   d. Utilization Potential Analysis (Rationale and Results of Analyses)
   e. Waste Lists (IBM Printout of Waste Lists and Data by Subsystem/Experiment)

2. Utilization Processes
   a. Discussion (Summary and Organization of Section)
   b. Processing Data (Data and Trade-Off Information on Each Process)

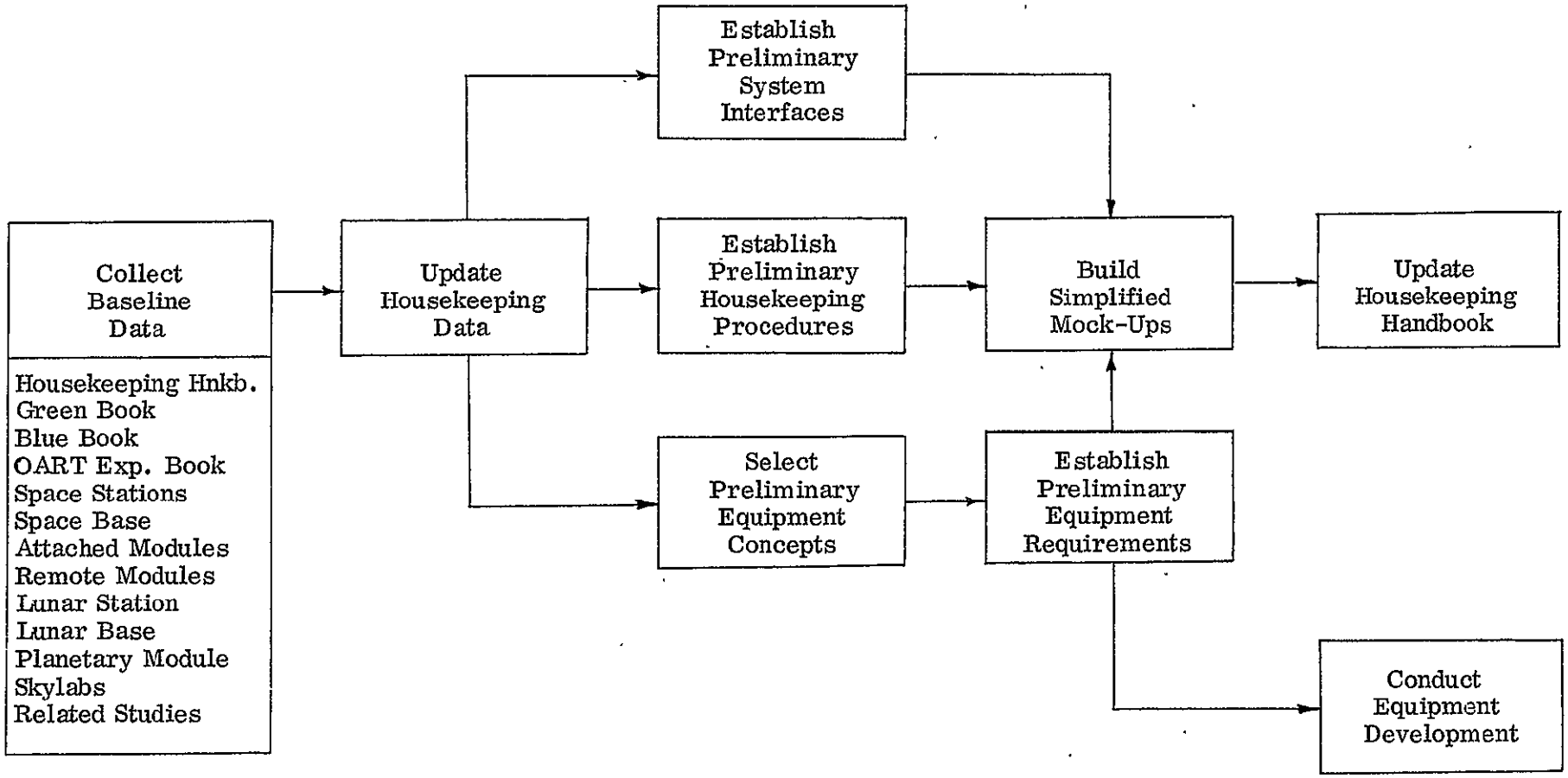
3. Predisposal Processes
   a. Discussion (Summary and Organization of Section)
   b. Processing Data (Data and Trade-Off Information on Each Process)

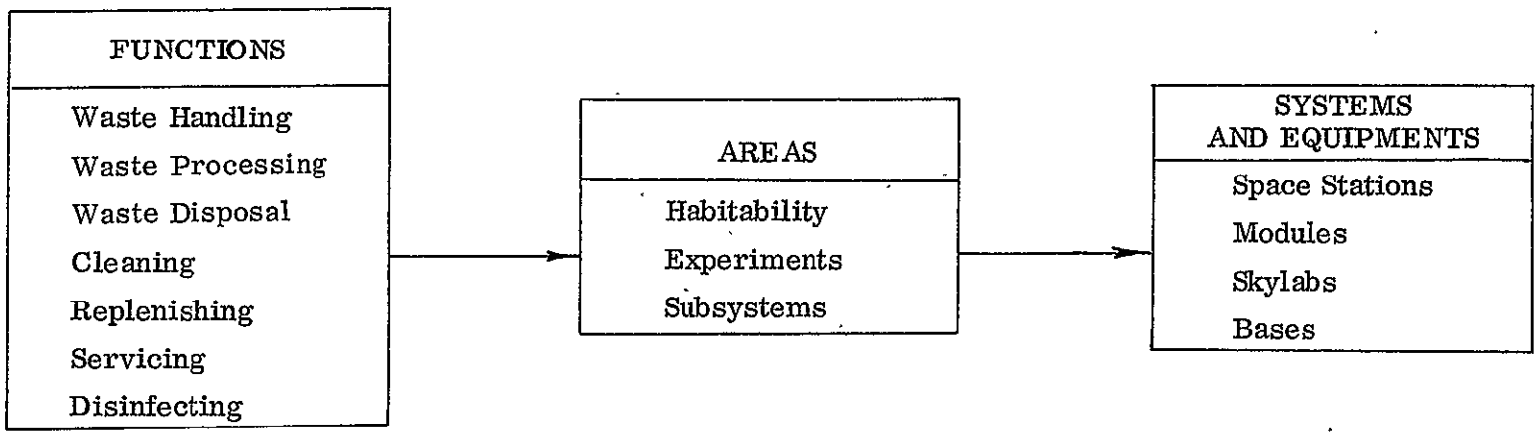
4. Disposal Techniques
   a. Discussion (Summary and Organization of Section)
   b. Disposal Data (Data and Trade-Off Information on Each Disposal Technique)

5. Waste Control and Housekeeping
   a. Discussion (Summary and Organization of Section)
   b. Collection and Sorting (Temporary Containerization; Automated versus Manual)
   c. Transfer (Transfer Equipment; Automated versus Manual)
   d. Task and Time Line Analysis Data (Man-Machine Interface)
   e. Crew Support of Utilization Processors (Task and Time Line Data)
   f. Crew Support of Disposal and Predisposal Processors (Task and Time Line Data)

6. Search/Report Computer Program

   (Discussion of Capabilities of Program and Detail Instructions For Use)


Collect Baseline Data
Housekeeping Hnkb.
Green Book
Blue Book
OART Exp. Book
Space Stations
Space Base
Attached Modules
Remote Modules
Lunar Station
Lunar Base
Planetary Module
Skylabs
Related Studies
Update Housekeeping Data
Establish Preliminary System Interfaces
Establish Preliminary Housekeeping Procedures
Select Preliminary Equipment Concepts
Build Simplified Mock-Ups
Establish Preliminary Equipment Requirements
Update Housekeeping Handbook
Conduct Equipment Development


FUNCTIONS
Waste Handling
Waste Processing
Waste Disposal
Cleaning
Replenishing
Servicing
Disinfecting
AREAS
Habitability
Experiments
Subsystems
SYSTEMS AND EQUIPMENTS
Space Stations
Modules
Skylabs
Bases